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LASER-ZONE GROWTH IN A RIBBON-TO-RIBBON (RTR) PROCESS
SILICON SHEET GROWTH DEVELOPMENT FOR THE LARGE AREA
SILICON SHEET TASK OF THE LOW COST SILICON SOLAR
ARRAY PROJECT

(NASA-CR-155586) LASER-ZONE GROWTH IN A
RIBBON-TO-RIBBON, RTR, PROCESS SILICON SHEET
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ANNUAL REPORT

September 1977

JPL CONTRACT NO. 954376

BY

R. W. GURTLER, A. BAGHDADI, R. J. ELLIS, R. LEGGE, B. SOPORI

PREPARED BY

MOTOROLA INC. SEMICONDUCTOR GROUP
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California Institute of Technology, under NASA Contract NAS7-100
for the U.S. Energy Research and Development Administration,
Division of Solar Energy.

The JPL Low-Cost Silicon Solar Array Project is funded by ERDA
and forms part of the ERDA Photovoltaic Conversion Program to
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Motorola Project No's 2319-25

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ABSTRACT

The objective of this research is to fully investigate the Ribbon-to-Ribbon (RTR) approach to silicon ribbon growth. An existing RTR apparatus is to be upgraded to its full capabilities and operated routinely to investigate and optimize the effects of various growth parameters on growth results. A new RTR apparatus is to be constructed to incorporate increased capabilities and improvements over the first apparatus and to be capable of continuous growth. Material analyses and solar cell fabrication process optimization are to be performed with a goal of 12% cell efficiency.

During this quarter major progress towards completion of the new laser lab has been made with full operation expected in October. RTR #1 has been used for routine growth of samples for analysis and fabrication into solar cells. One lot of solar cells has been completely evaluated: ribbon solar cell efficiencies averaged 9.23% with a highest efficiency of 11.7%. Spherical reflectors have demonstrated significant improvements in laser-silicon coupling efficiencies. Numerous material analyses have been performed including SPV and OCPV diffusion length measurements, crystal morphology studies, modulus-of-rupture measurements, and annealing/gettering studies. An initial economic analysis has been performed indicating that RTR add-on costs of a \$.10/watt might be expected in the early 1980's.

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SUMMARY

RTR #1 has been used for routine growth of numerous samples which have been used for material analysis, fabrication of solar cells, and other specific experiments. 1" wide samples have been grown using the spherical reflector concept to enhance laser coupling. The reflectors have been shown to be quite effective and will be important for the long-range economics of RTR growth.

The new laser lab is nearing completion. Full operation is expected in October with initial experiments with the large lasers and high frequency scanners to be performed on RTR #1.

Thermal stress analysis experiments continue to demonstrate negligible residual stresses when the linear temperature profile furnace is used, but high dislocation densities prevail. New thermal profile modification techniques are being developed to attempt to better control the first few millimeters of growth.

Sectioning of ribbon samples is reported; it illustrates the shape of the molten zone and the variation in thickness across a grown ribbon: over 99% of the ribbon width may be processed without penalty due to ribbon thickness variations.

A study of dominant grains appearing from polysilicon feed stock seems to show that their orientation is random regardless of whether curved or flat molten zones are utilized.

Modulus of rupture measurements performed on RTR samples indicate a worst-case strength of approximately one third that of single crystal ribbon.

Two lots of solar cells fabricated from RTR ribbons have been evaluated. The first lot demonstrated average ribbon solar cell efficiencies of 9.23%

and control cell efficiencies of 12.66%. The second lot was evidently processed incorrectly resulting in fair J_{SC} but poor fill-factors and low V_{OC} . The control cells for this group had an average efficiency of only 7.6%. A third lot of cells will soon be evaluated.

An initial economic analysis of the long-range capabilities of the RTR process has been performed using costing data typical of Motorola in-house analysis, and, assuming a linear extrapolation of the ribbon throughput as the laser power is increased. We obtain a projected add-on cost of RTR ribbon in the range of \$0.08 - \$0.13/watt for ribbon grown at 20cm/min. in the early 1980's.

1.0 MODEL 1 RTR APPARATUS

RTR #1 is being used for various thermal environment experiments as well as for routine sample growth. During this quarter a large number of samples were produced for material analysis and for solar cell starts. Experiments have also been performed to demonstrate the usefulness of the hemispherical reflectors in an actual RTR growth situation. Other experiments were performed in attempts to improve the thermal stress environment during growth.

A few problems were encountered which sometimes altered the normal growth routine. For example, during one period, only one beam scanner was available while two scanners (the second normal scanner and a spare) were simultaneously being repaired. This necessitated growth of samples with single-side irradiation for that period. The linear temperature profile post-heater required some repairs causing some down time. Also, a beam splitter had to be replaced.

1.1 RIBBON GROWTH RUNS

Numerous growth runs were made this quarter with a variety of growth parameters. Except as noted above, most samples were grown with irradiation from both sides. Both locked and ratio growth modes were utilized. In the latter case, a 2:1 uptake:feed ratio was normal.

Feedstock for most growth runs was single crystal Czochralski material: .5" wide, .01" thick, 3-5 Ω cm, p-type. Recently, a series of growth runs were performed using, 1" wide samples. Both (110) and (100) orientation feedstock were used. Some growth runs were also made utilizing undoped polysilicon.

Samples were allocated for solar cell fabrication, JPL samples, material characterization, or for specific experiments involving stress measurements, utilization of hemispherical reflectors, etc.

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1.2 SPHERICAL REFLECTOR EXPERIMENTS

The effectiveness of the spherical reflectors in an actual RTR growth situation has been investigated. For these experiments two quarterspheres were slotted for allowance of the entering scanning laser beam and were further altered to allow for a close fit with the furnace. Allowance for passage of the ribbon through the quarterspheres into the furnace was also provided.

Some difficulties were encountered in aligning the reflectors properly, but this was expected. To alleviate the problem, a remote positioning apparatus (previously designed for remote ribbon positioning) was adapted for one quartersphere. This allowed remote positioning of the quartersphere during a growth run and reasonably good heat zones could be achieved. However, only one quartersphere positioning system was available; consequently only single-side irradiation was used.

Results

The effectiveness of the quartersphere was conclusively demonstrated. If a stationary laser beam were used to create a primary molten spot, a secondary molten spot could be achieved at a conjugate point equidistant from the sphere center. As the spot was moved, the secondary spot would move in an opposite direction and would be superimposed at the center of the ribbon. Under a scanning mode, two scanning beams are created; they scan in opposite directions and effectively double the scan speed.

It appears that by far the major benefit of the quartersphere is due primarily to the return and reimaging of the nearly specularly reflecting primary beam. Little benefit was observed in reduction of radiation losses from the melt, but the quality of the reflector utilized for these experiments was not exceptionally good; possibly even this effect will be observed when

both quarterspheres can be utilized which are of higher quality and incorporate more accurate positioning.

Some growth runs were achieved with the single quartersphere. One inch wide samples were used. Table 1 exhibits results of one experiment which amply demonstrates the effectiveness of the use of a single quartersphere. As the table indicates, sample #587 (with quartersphere) could be grown 2.5 times as fast as sample #588 (without the quartersphere) and with 15% less power. Significantly, with single-sided irradiation, there is no question as to whether the sample is completely melted since melt-through can easily be observed on the side opposite the irradiation.

TABLE I

<u>SAMPLE</u>	<u>WIDTH</u>	<u>THICKNESS</u>	<u>IRRADIATION</u>	<u>POWER</u>	<u>GROWTH RATE</u>
#587	1"	.01"	30° Incidence W/Quartersphere	370W	.45"/min
#588	1"	.01"	30° Incidence Without Quartersphere	430W	.18"/min

Another observed benefit from the use of spherical reflectors is the effective doubling of the scan speed. This resulted in significantly smoother surfaces on the irradiated side when a quartersphere is used.

The ultimate benefit to be gained from the hemispherical reflectors cannot be ascertained until quarterspheres can be utilized on both sides of the sample. Previous experiments with normal incidence scanning have demonstrated improved performance when both sides are irradiated as compared to single-side irradiation. Since the economics of ribbon growth will depend substantially upon the size of laser utilized and the efficiency of energy utilization, these

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considerations are quite important. Unfortunately, the difficulty encountered in working the reflectors into the system may preclude their routine use until a fixed geometry growth chamber is achieved in a production unit.

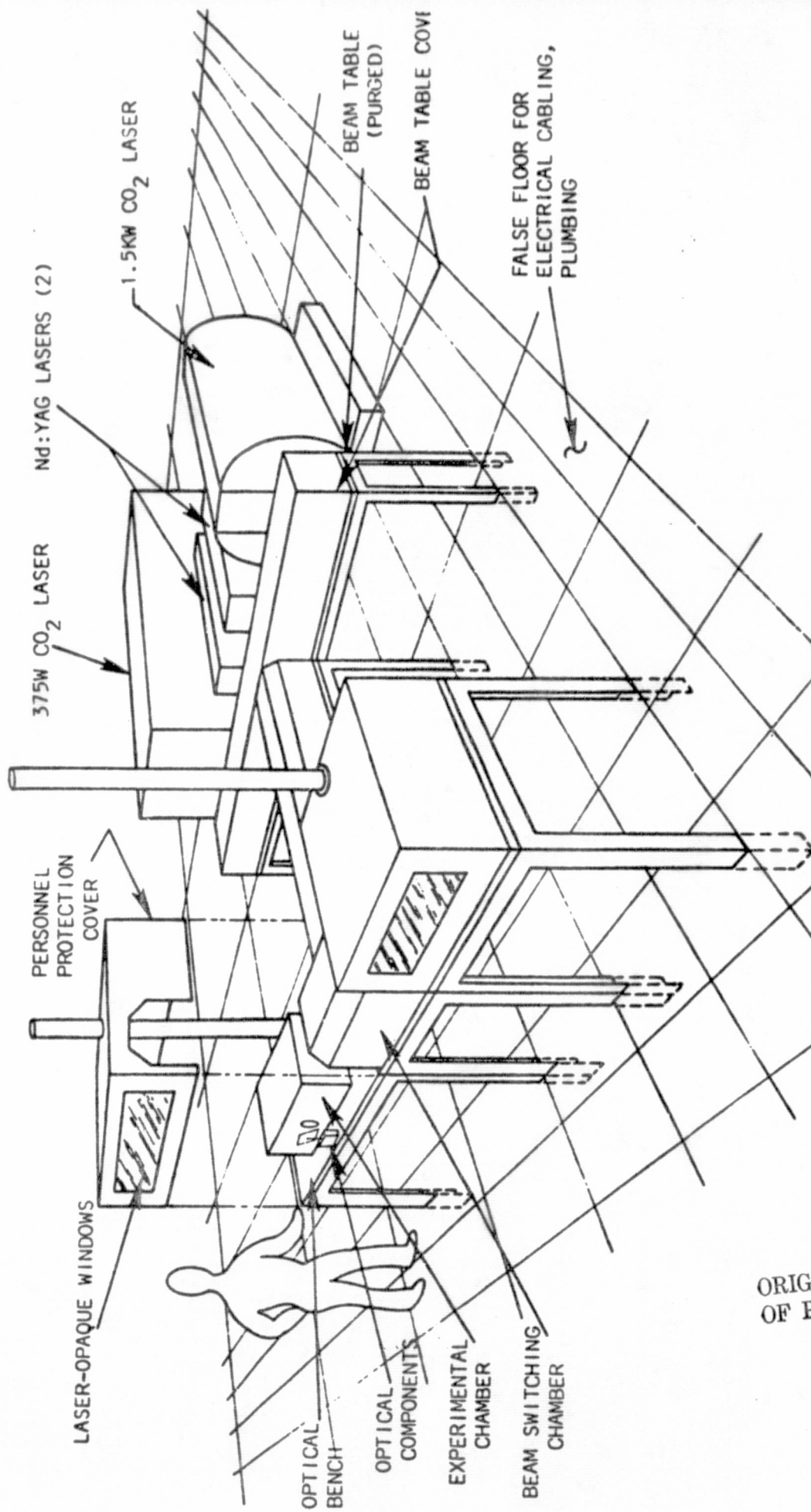
2.0 NEW RTR LASER LAB

Facilitization delays for the new RTR lab (see Figure 1) have significantly delayed the assembly of the new RTR apparatus, RTR#2. However, assembly is now proceeding, albeit slowly. At present the large CO₂ laser, one of two Nd:YAG lasers, the beam directing tables, and the RTR#1 and RTR#2 experimental tables are in place. RTR#1 is being reassembled first so as to make use of the higher power lasers at the earliest date possible.

3.0 THEORETICAL AND EXPERIMENTAL THERMAL STRESS ANALYSIS

3.1 THEORETICAL

A computer code for analysis of the thermal profiles and shape of the melt interface has been located. This program will allow material parameters to be introduced either as data files or as an explicit equation. The initial goals for this program will be to provide some insight into the shape of the melt as a function of velocity and laser input parameters, and also to provide the thermal profile for the after-melt region as a function of auxiliary heating/cooling/shielding configurations. As a necessary part of this program, a literature search will be made to obtain current estimates of material properties versus temperature.



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FIGURE 1: LASER LAB

Once the thermal analysis program is on line, the generated thermal profiles will be entered into a linear elastic computer code which will indicate the distribution and magnitude of elastic stresses generated. Although such an analysis is clearly wrong due to the occurrence of plastic flow and stress relief, it will nevertheless be useful as temperature profiles are altered to indicate the effects on stresses.

As a next approximation, it may be useful to utilize some simple procedure to allow complete stress relaxation to a yield stress at points where stresses exceed the yield stress and then iterate to produce a consistent result.

3.2 EXPERIMENTAL

Experimentally, the stress-birefringence technique continues to be used for the analysis of residual stresses in ribbons. Experiments reported in the June Quarterly showed that residual stresses still do occur if the furnace is not optimized. Subsequently, it was found that an incorrect procedure was being used to profile the furnace. Correction of this procedure has again demonstrated that residual stresses under routine growth conditions are quite low and insignificant in regards to handling or as a possible growth velocity limitation.

Of more importance is crystal quality. Wright etching of samples continues to demonstrate high dislocation densities. As indicated in the June, 1977 Quarterly Report, these dislocations arise because of the stress field immediately adjacent to the melt, i.e., between the melt and the start of the linear temperature profile.

3.2.1 DISLOCATION DISTRIBUTION EXPERIMENT

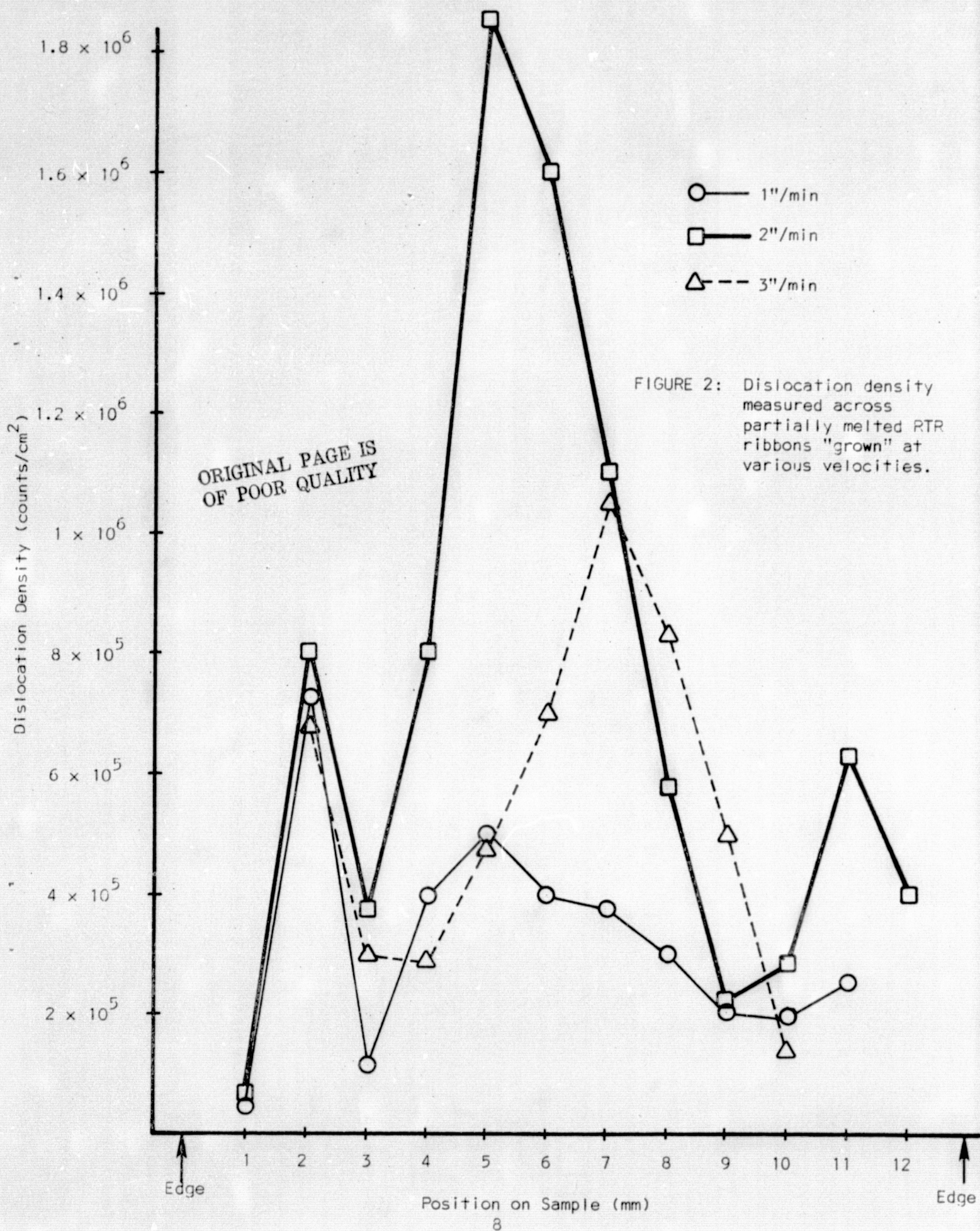
An experiment was performed to determine the nature of this stress field by measuring the dislocation pattern induced into single crystal samples passed through the RTR apparatus. These samples were partially melted from both sides so that upon freezing, seeding would occur from the unmelted central portion. This results in single crystal samples, but yet the samples undergo essentially the same thermal environment as do normal RTR samples. What is different is that RTR samples can accommodate stress relief at grain boundaries while single crystal samples cannot. Consequently, even higher dislocation densities would be expected for these single crystal samples.

Figure 2 illustrates the steady-state dislocation density distribution measured across the samples. "Growth" velocities of 1"/min, 2"/min, and 3"/min were used.

The dislocation density distribution is similar to that reported earlier in the June, 1977, Quarterly. Higher growth velocities would be expected to effect a softening of the thermal gradient near the melt since latent heat is being carried along with the sample; therefore higher growth velocities would be expected to exhibit lower dislocation densities. As can be seen in Figure 2, the highest dislocation densities are actually obtained at 2"/min, the 3"/min densities are significantly lower, but not as low as the 1"/min dislocation densities.

3.2.2 CONCLUSION

The samples reported here exhibited negligible residual stresses but very high dislocation densities. The geometry of the present system is not conducive to a great improvement in the thermal profile very near the melt. In addition, as growth velocities become higher, the relatively low thermal



gradient being imposed by the linear profile furnace will become detrimental to heat removal. Consequently, new thermal profile elements are indicated if low dislocation densities are to be achieved.

Some new profile modifying elements are now being designed; they will attempt to achieve higher thermal gradients but yet achieve more linear temperature profiles immediately adjacent to the melt.

4.0 RIBBON CHARACTERIZATION

4.1 SPV DISLOCATION DISTRIBUTION

Ribbons typical of those utilized for solar cell processing were analyzed for dislocation densities and diffusion lengths. Figure 3 illustrates such a sample. Point dislocation and line dislocation densities vary considerably. Diffusion lengths are still typically 6 - 12 μ m and do show some (slight) correlation with dislocation densities.

4.2 CRYSTAL MORPHOLOGY

Figures 4 - 6 are photos of polished sections showing the morphology of the growing crystal. Figure 4 is a cross-section taken parallel to the growth direction, through the molten zone. This sample (#374) was grown with a 2:1 pull/feed ratio. Note that the thickness of the molten zone, as frozen in, is larger than that of the feed and uptake regions. This occurs primarily due to uptake of material from the edges. This "bulge" is observable during growth when observed with an edge viewing camera. Figures 5a, b, are cross-sections taken across the width of sample #374, showing the edge and a center section. Figure 5c is a section of the feedstock used for the growth of sample 374.

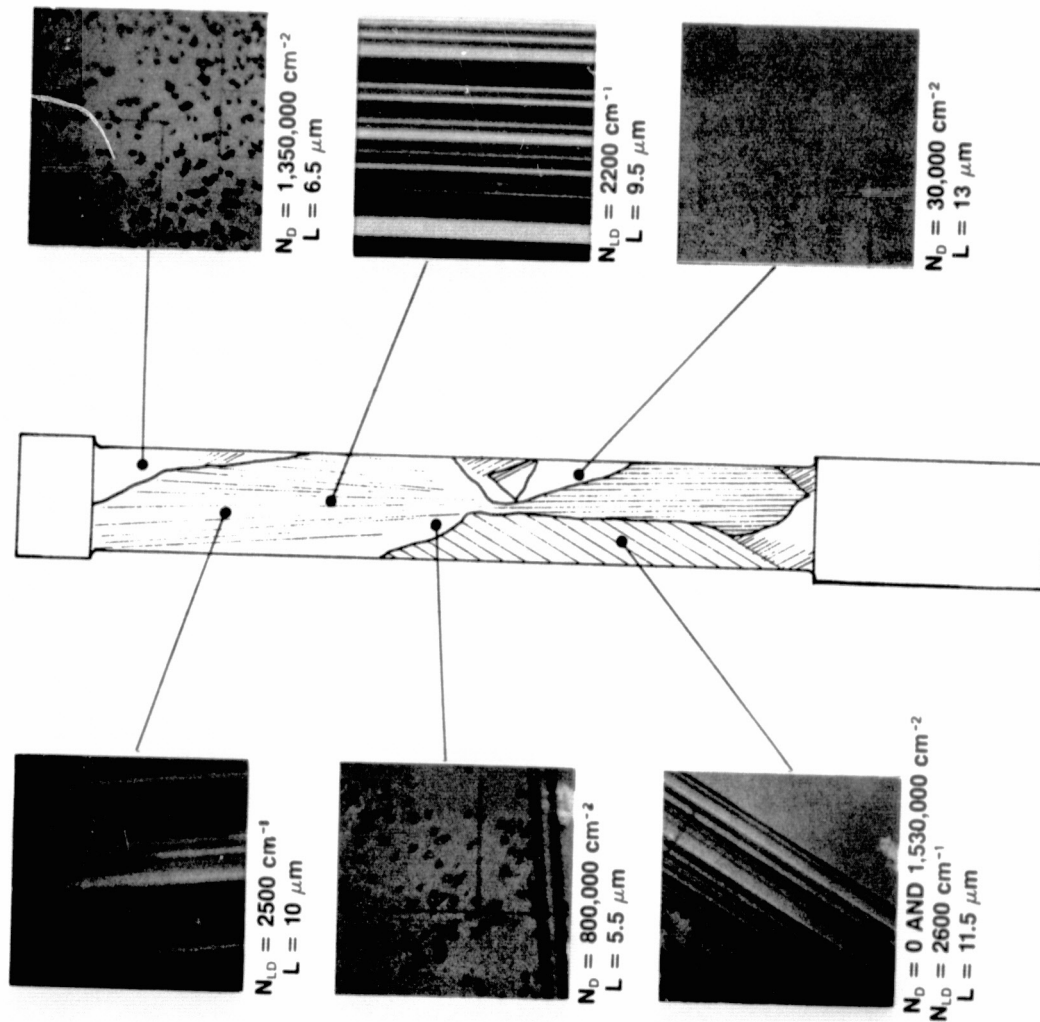
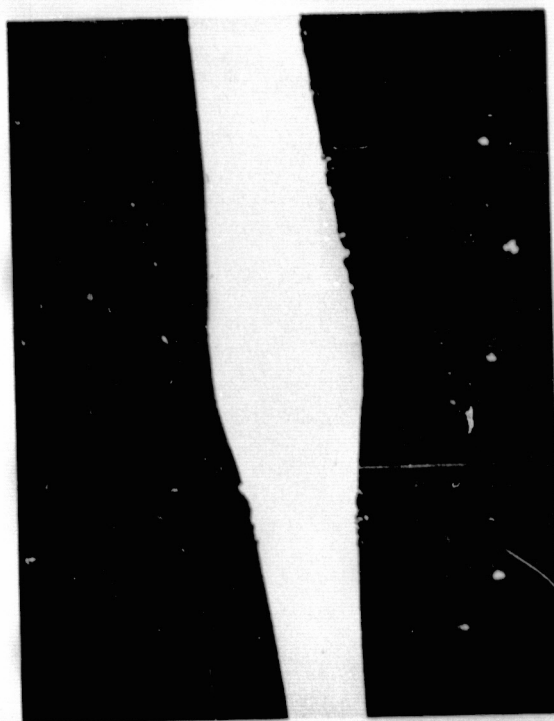


FIGURE 3: Linear and Point Dislocation Densities, and SPV diffusion lengths measured on typical RTR Ribbon.

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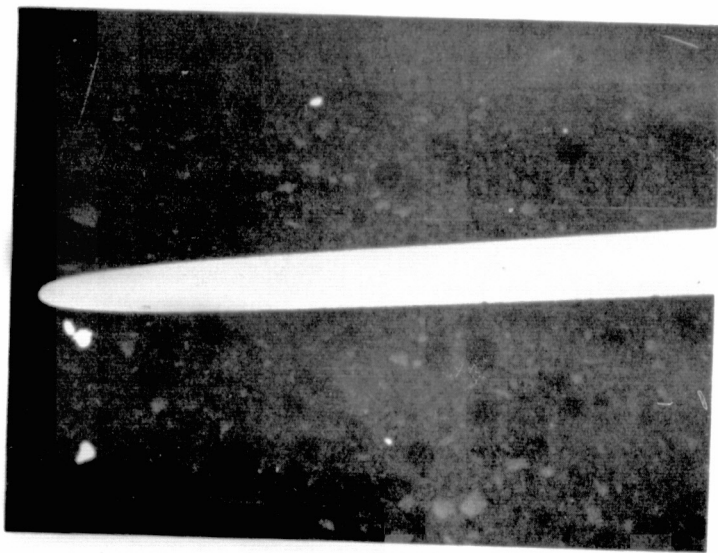
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GROWN RIBBON

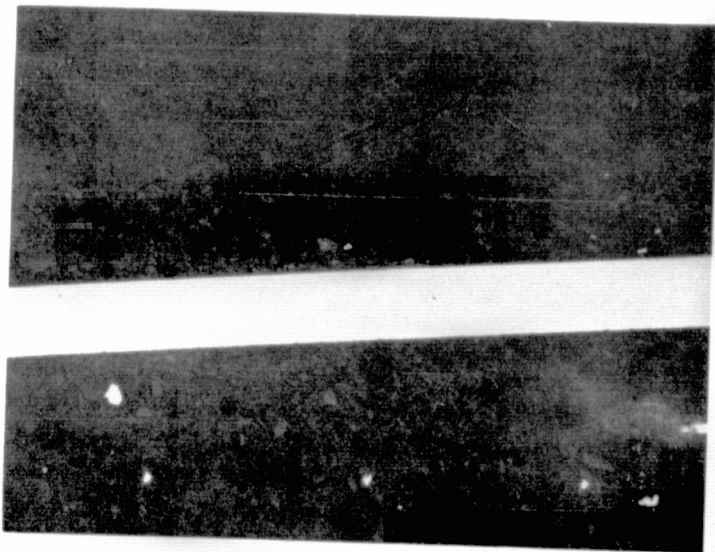


FEEDSTOCK

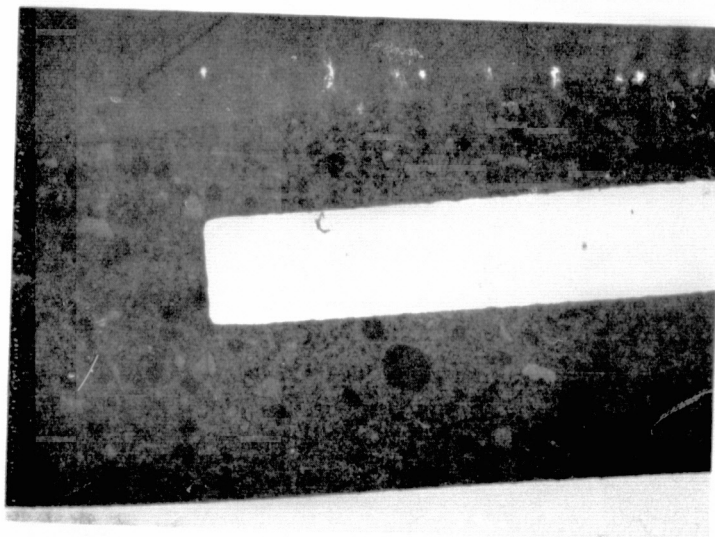
FIGURE 4: Cross-Section of the Molten
Zone, Sample 374



(a)



(b)



(c)

FIGURE 5: Cross-Section, Sample 374

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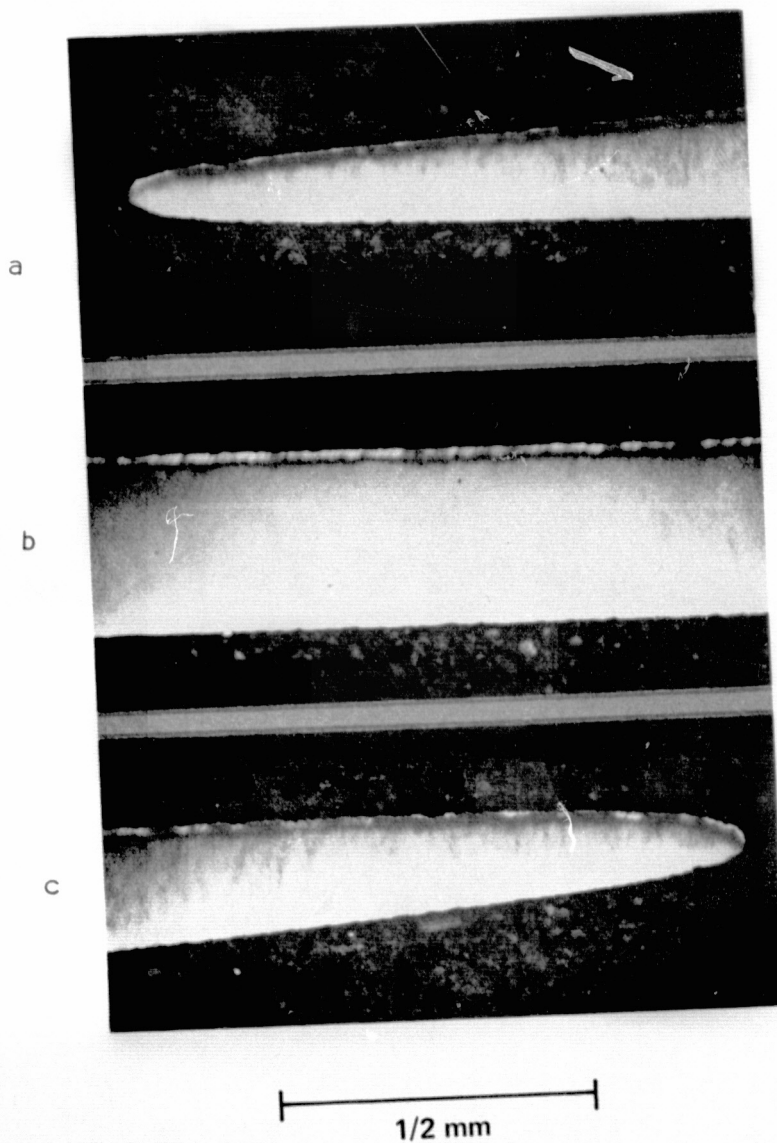


FIGURE 6: Cross-Section, Sample 417

Figure 6 is a cross-section across the width of sample #417, which was grown with a 1:1 pull/feed ratio. Figures 6a, c are opposite edges of the sample, while 6b is a center section.

Sample 374 is 110 μ m thick, which is probably close to the economically optimum ribbon thickness. It reaches a useful 50 μ m thickness* within 70 μ m of the edge and is of essentially maximum thickness 1/2mm from the edge.

Thus, solar cells can be fabricated on well over 99% of the ribbon width without penalty due to thickness variation.

Figures 7a, b, c are photos taken of the cross-section of sample 417 after a 5 minute Wright etch. The linear defect density ranges from the low density of stacking faults or coherent twins observed in 7a to the $>10^3$ /cm density observed in 7c.

4.3 CRYSTAL ORIENTATION

The orientations of the dominant grains in a number of samples grown from polycrystalline feedstock were determined by Laue crystallography. The results are listed in Table II. Although in each case a single orientation took over the entire crystal width, the eventual choice of orientation appears random using either a flat or a curved molten zone.

4.4 MODULUS OF RUPTURE (FLEXURAL STRENGTH) OF RTR RIBBON

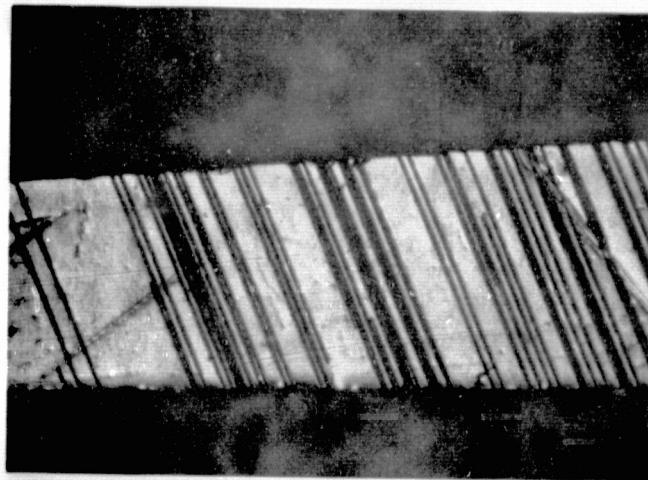
The modulus of rupture of RTR silicon was measured using a 3-point loading technique similar to that described in ASTM F417-75T.

We measured the modulus of rupture on 4 RTR samples, as well as on 4 Czochralski samples with dimensions identical to the RTR samples. The measurements were made on an Instron Model #TTC.

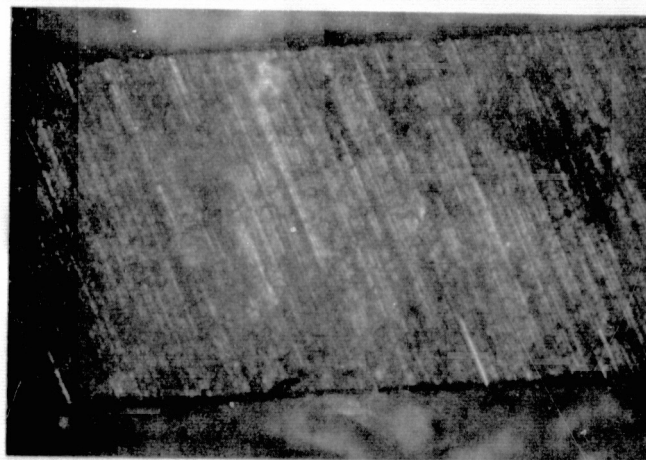
* Westinghouse reports an 11% cell on 50 μ m ribbon.



(a)



(b)



(c)
FIGURE 7: Ribbon Cross-Sections
After Wright Etch

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TABLE II

ORIENTATION OF DOMINANT GRAINS			
SAMPLE	CURVED MOLTEN ZONE	SAMPLE	FLAT MOLTEN ZONE
417	(213) $[253]$	462	(211) $[\sim 011]$
418	$\sim(110)$ $[1\bar{1}1]$	464	(110) $[1\bar{1}2]$
426	(351) $[3\bar{2}1]$	466	$\sim(110)$ $[1\bar{1}1]$
421	$\sim(100)$ $[100]$	468	(123) $[2\bar{1}0]$

For the first sample (cut from RTR #501), the load was applied at right angles to the growth direction. The other three samples were cut from RTR #514, and the load was applied parallel to the growth direction. The results are given in Table III.

For comparison, values for the modulus of rupture of silicon quoted in Runyan (1) are also given in Table III. Since the ribbon would tend to break at its weakest point, the lowest value quoted (7600 psi) would indicate a worst case strength of approximately one third that of single crystal silicon.

4.5 ANNEALING/GETTERING EXPERIMENTS

In order to understand the short diffusion lengths exhibited by ribbon substrates, some experiments have been initiated on single crystal Czochralski and float zone material. The purpose of these experiments is to determine the effects of various temperatures and gas ambients on the diffusion length of known quality materials. Gettering cycles are also to be evaluated to determine their effectiveness in preventing diffusion length degradation, or recovering normal diffusion lengths after degradation. These experiments (together with other techniques) are expected to lead to an understanding of the short diffusion lengths obtained in RTR-like samples which do not have obvious structural problems. Figures 8 through 11 exhibit the experiments performed to date. In these experiments N_2 and N_2-O_2 ambients were utilized for 1 hour or 10 minutes (these were to simulate inert atmospheres as well as oxidizing atmospheres which might be experienced in processing). The gettering cycle used was phosphorous ($1100^{\circ}C$, 12 min.). Under each operation are SPV measured diffusion lengths from wafer sections undergoing the operation and on a control (C) wafer section (same wafer) not undergoing the operation.

(1) W.R. Runyan "Silicon Semiconductors Technology", McGraw-Hill, N.Y. 1965

TABLE III. MODULUS OF RUPTURE OF RTR SILICON

Crystal Form (Runyan)				Modulus of Rupture (psi)
Single Crystal Silicon Whiskers				200,000
Smooth Silicon Bars				20,000 to 60,000
CZ crystals, sawed and etched				10,000 to 20,000
<u>SAMPLE I.D.</u>	<u>LOAD POINTS</u>	<u>WIDTH & THICKNESS</u>	<u>LOAD DIRECTION</u>	<u>MODULUS OF RUPTURE (PSI)</u>
501	3.1"	0.5" X 0.0095"	Load Applied Perpendicular to Growth Direction	48,000
CZ #1	3.1"	0.5" X 0.010"		22,000
CZ #2	3.1"	0.5" X 0.010"		21,000
514a	0.375"	0.5 X 0.0125"	Load Applied Parallel to Growth Direction	7,600
514b	0.375"	0.5" x 0.0125"		19,000
514c	0.375"	0.5" x 0.0125"		32,000
CZ #3	0.375"	0.5" x 0.011"		24,000
CZ #4	0.375"	0.5" X 0.011"		22,000

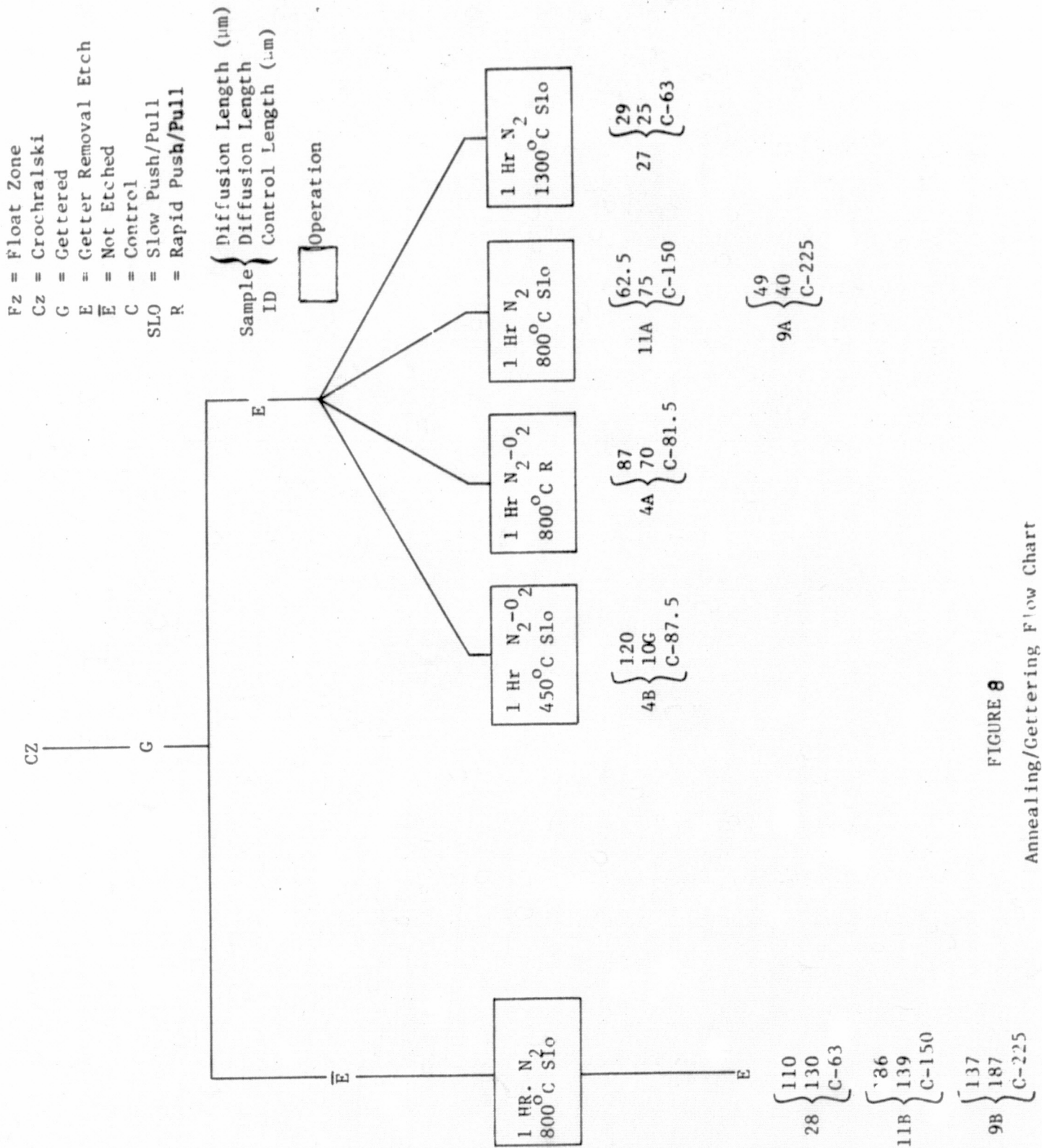
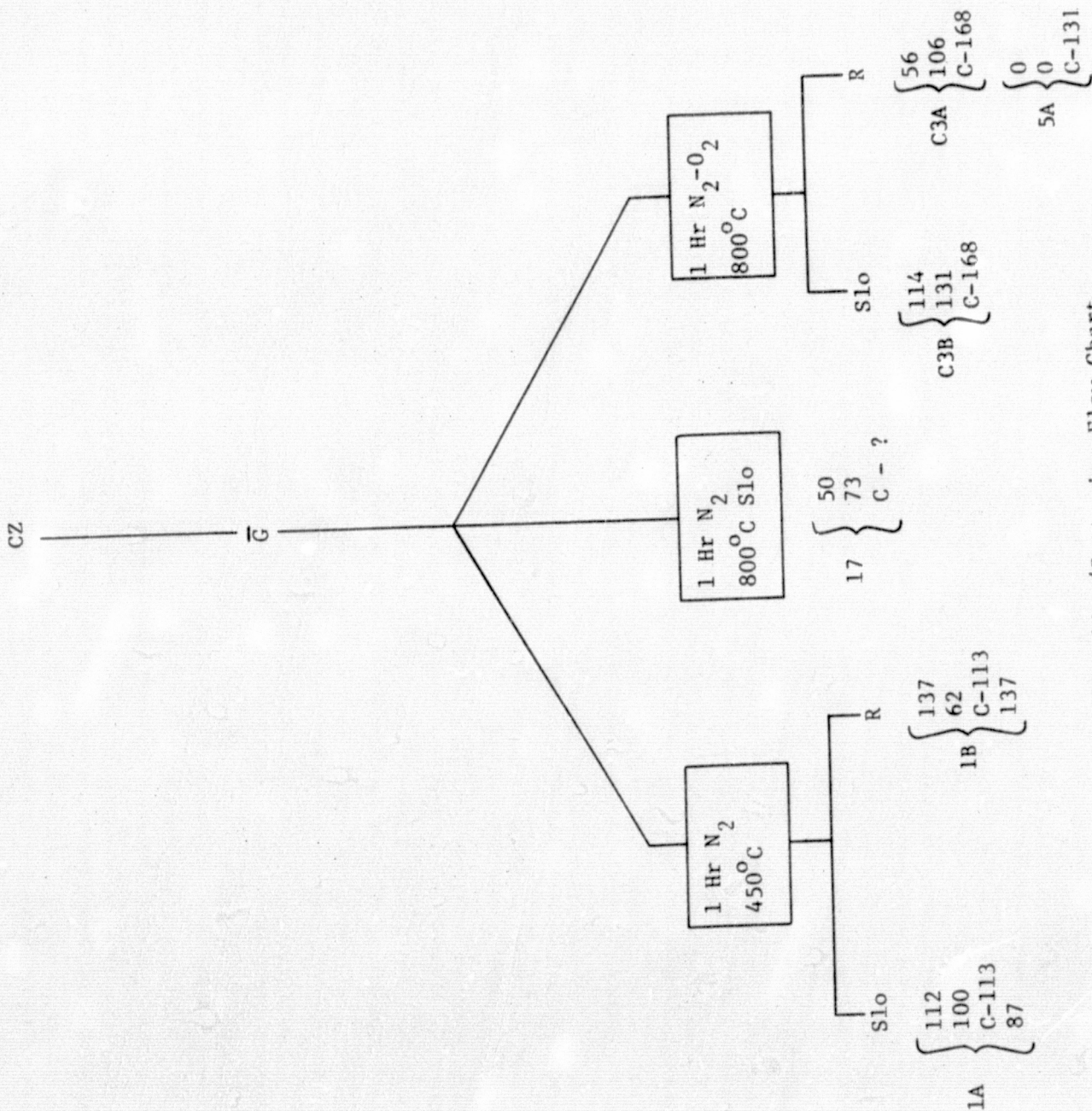


FIGURE 8
Annealing/Gettering Flow Chart

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Annealing/Gettering Flow Chart

FIGURE 9

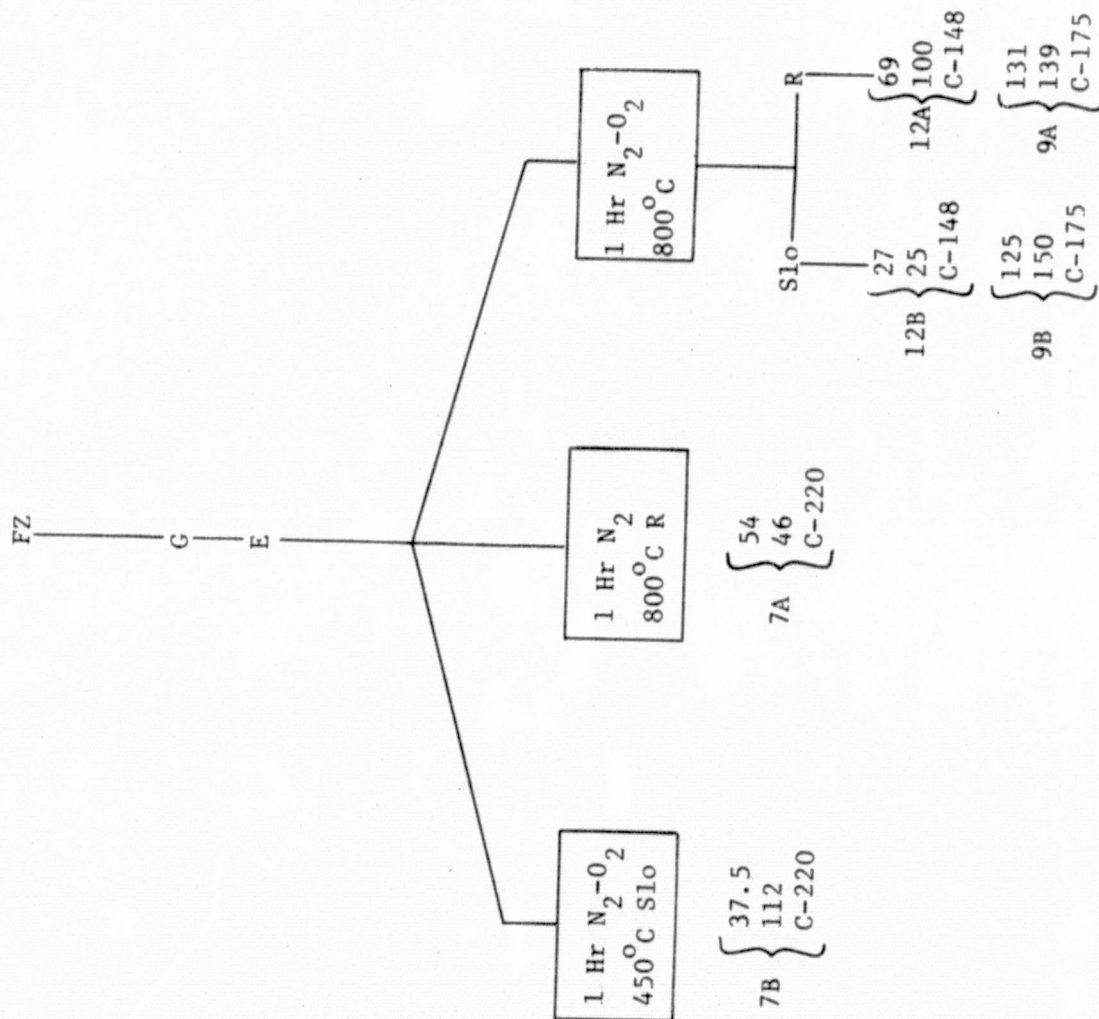
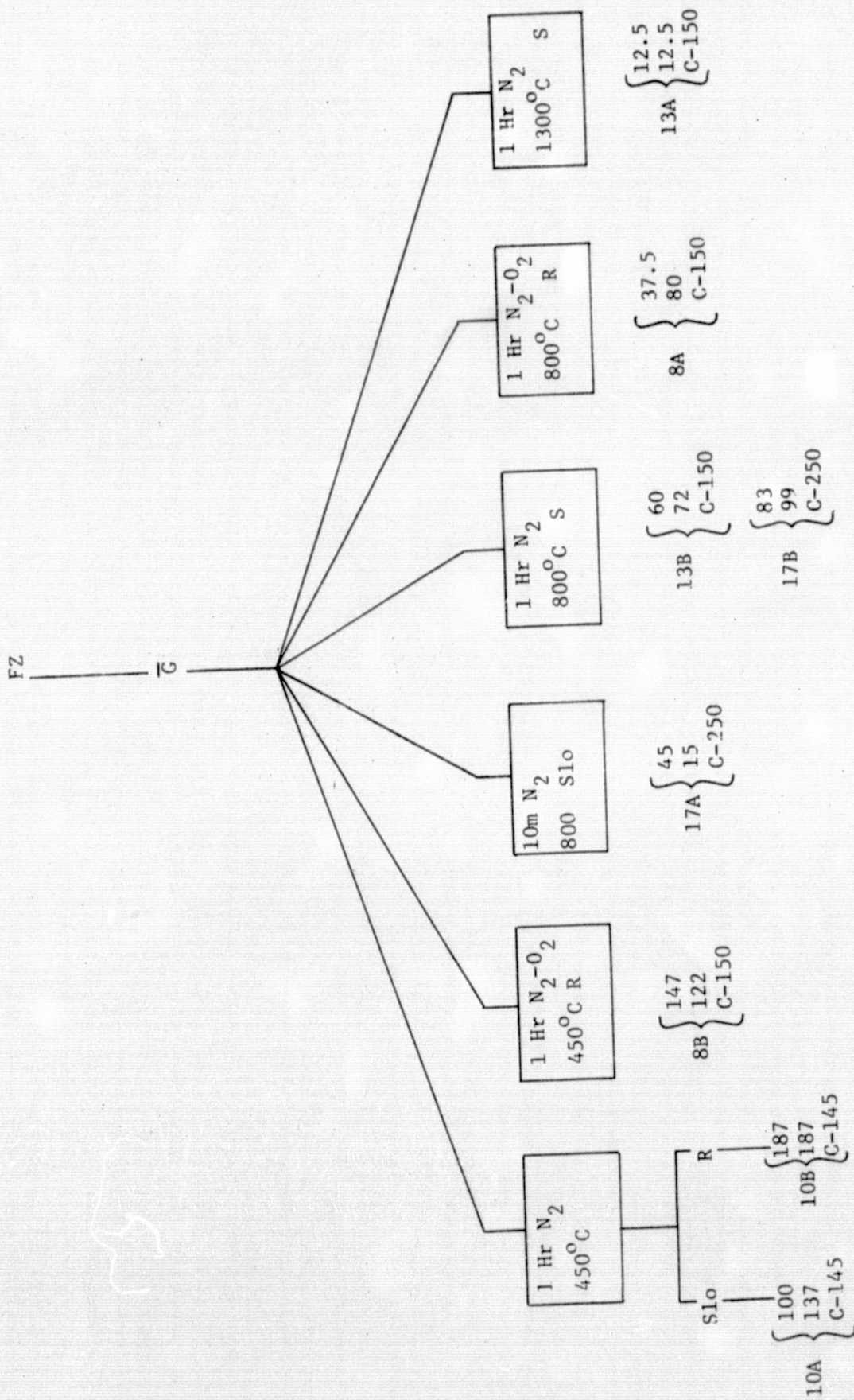


FIGURE 10
Annealing/Gettering Flow Chart

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Annealing/Gettering Flow Chart

Figure 11

From these few experiments we note the following:

- . No significant degradation occurs at 450°C
- . Degradation occurs at 800°C except when the getter layer has not been removed (continues to getter).
- . The presence of oxygen does not seem significant
- . Degradation at 1300°C is severe regardless of sample type and the atmosphere
- . Degradation can occur rapidly (10 min) at 800°C

These data are too meager, and the results sufficiently scattered, to preclude further conclusions. The use of SPV measurements to determine the effects of processing steps seems powerful, though. Many more samples will be processed to evaluate the effects of:

- . Furnace contamination
- . Gaseous ambients (Argon, N₂-H₂ etc.)
- . Temperature
- . Passivation layers

If a baseline, high temperature (1200 - 1300°C) temperature cycle can be established which does not degrade lifetime, then a basis for comparison with the RTR environment will be established, and various precleaning steps, gas ambients, furnace components, etc., may be evaluated.

Indications at present are that structure, per se, is not the limiting factor on our ribbon. This indicates either that precleaning steps, ambient contamination, or inherent material properties are leading to the low diffusion lengths. Some experiments performed with various starting materials of different origin, e.g., float zone, Czochralski, large grain Wacker doped polysilicon, and doped CVD silicon, all have resulted in short diffusion lengths. These experiments all point to contamination of the material, if indeed the structure is not the main effect.

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4.6 IMPURITY ANALYSIS

RTR samples, control samples taken from the unmelted ends of the RTR ribbons, and control samples obtained from sawn Czochralski crystals are being sent to Applied Research Labs, Sunland, California for impurity analysis using Secondary Ion Mass Spectroscopy (SIMS). We are also sending a smaller number of samples to the Materials Research Laboratory at the University of Illinois. They will also perform SIMS (and possibly SSMS) analysis, and provide a valuable cross-check for the Applied Research results.

4.7 ELECTRON MICROSCOPY

We have sent an RTR sample containing 1mm diameter ribbon diodes to the electron microscopy facility at Motorola SRDL. We expect to obtain SEM and EBIC micrographs of the diodes, and we will attempt to correlate the EBIC results with the diode performance as a solar cell.

5.0 SOLAR CELL DEVELOPMENT, FABRICATION, AND TESTING

Solar cells are being fabricated on RTR samples in the Motorola Solar Energy Department by the processing R&D/production group. A phosphorous diffused junction is used together with the standard AR coating procedure used for production cells. For the first group of cells, texture etching has also been incorporated. The rationale for this was that even though RTR ribbons do not have the desirable (100) surfaces, "intermediate" texture etching would possibly occur with some increased absorption.

At present, one complete group of cells has been evaluated and a second group partially evaluated.

5.1 SOLAR CELL EVALUATION

Table IV is a complete compilation of evaluations performed on ribbon solar cells from the first group. Indicated are efficiencies, fill factors, type of cell [control (C) or ribbon (R)] and whether a cell was probe rejected. For this batch, the overall probe yield was 77%, the control cell yield was 82%, and the ribbon cell yield was 70%. The major cause of probe reject was due to poor metallization and breakage.

For this group of cells the average control cell efficiency was 12.66% while the average ribbon cell efficiency was 9.23%. The highest ribbon efficiency was 11.7%. All of these measurements were performed using a simulated solar source. Our past experience is to observe slightly higher efficiencies when measured outdoors in a true solar spectrum.

The variation in control sample efficiencies is probably the result of heating effects during ribbon growth. Most controls were simply regions of the feedstock which were not melted but nevertheless experienced elevated temperatures. Sample 100-P-1, however, was not subjected to this heating and exhibited uniformly high efficiencies.

5.1.1 JUNCTION DEPTH

The p-n junction depth was measured on three ribbon solar cells: a control cell, a cell with 11% efficiency and a cell with 8.5% efficiency. The results indicate a correlation between the junction depth and inferior cell performance. However, we do not feel these are "reportable" results, since the measurement was made on only one sample of each kind. We will pursue this investigation with a larger number of samples.

TABLE IV

<u>DEVICE</u>	<u>TYPE</u>	<u>MATERIAL</u>	<u>COMMENTS</u>	<u>FILL FACTOR</u>	<u>EFFICIENCY</u>
357-1	C	Cz		0.75	13.5%
-2	C	Cz		0.74	14 %
-3	C	Cz		0.775	9.5%
-4	R	Cz	P.R.	1.65	8.5%
-5	R	Cz	P.R.		
-6	R	Cz	P.R.		
-7	R	Cz	P.R.		
361-1	C	Cz		.87	13.25%
-2	C	Cz		.73	14.7%
-3	C	Cz			
-4	R	Cz	P.R.	.72	11.1%
367-1	C	Cz		.78	15.6%
-2	C	Cz		.76	16.5%
-3	C	Cz			
-4	R	Cz	P.R.	.59	8.5%
-5	R	Cz	P.R.		
368-1	C	Cz		0.76	14.6%
-2	C	Cz		0.77	12.3%
-3	C	Cz		0.78	12.2%
-4	R	Cz	P.R.		
-5	R	Cz	P.R.		
-6	R	Cz	P.R.		
372-1	C	Cz		.74 (0.736)	14% (13.34)
-2	C	Cz	P.R.		
-3	C	Cz		.74	11.69%
-4	R	Cz		.68	8.68%
-5	R	Cz		.7	9.25%
-6	R	Cz	P.R.	.7	11.7%
-7	R	Cz	P.R.	.711	9.146%

NOTATION: C=Control, R=Rejection, Cz=Czochralski, P.R.=Probe Reject

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TABLE IV (continued)

DEVICE	TYPE	MATERIAL	COMMENTS	FILLFACTOR	EFFICIENCY
373-1	C	Cz	P.R.		
-2	C	Cz	P.R.		
-3	C	Cz	P.R.		
410-1	R	Wacker Doped Poly		.6	9.9%
-2	R	Wacker Doped Poly		.60	9.7%
-3	R	Wacker Doped Poly		.66	10.9%
-4	C	Wacker Doped Poly	Questionable Area Estimate	.65	10.8%
-5	C	Wacker Doped Poly		.71	13.2%
-6	C	Wacker Doped Poly		.7	12.8%
412-1	R	Wacker Doped Poly		.62	9.37%
-2	R	Wacker Doped Poly		.64	7.7%
-3	R	Wacker Doped Poly		Short	---
-4	C	Wacker Doped Poly	Questionable Area Estimate	.68	11.5%
-5	C	Wacker Doped Poly		.71	11.25%
-6	C	Wacker Doped Poly		.68	11.3%
413-1	R	Wacker Doped Poly		.65	8.0%
-2	R	Wacker Doped Poly		.63	7.25%
-3	R	Wacker Doped Poly		.634	9.6%
-4	C	Wacker Doped Poly	Questionable Area	.69	10.16%
-5	C	Wacker Doped Poly		.7	9.7%
-6	C	Wacker Doped Poly		.73	12.2%
100-P-1	C	Cz		.8	13.32%
-2	C	Cz		.75	13.23%
-3	C	Cz		.75	12.9%
-4	C	Cz		.77	12.9%
-5	C	Cz		.77	12.9%
-6	C	Cz		.76	12.9%
-7	C	Cz		.74	12.9%
Wacker	C	Wacker Doped Poly		.74	11.8%
Control	C	Wacker Doped Poly	Questionable Area Estimate	.77	12.42%
	C	Wacker Doped Poly		.8	13.15%
	C	Wacker Doped Poly	P.R.	----	-----

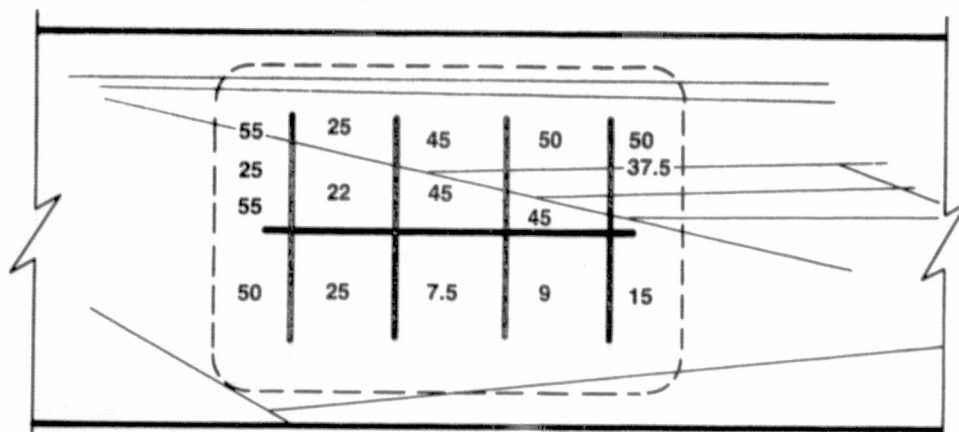
5.1.2 OPEN CIRCUIT PHOTOVOLTAGE MEASUREMENTS

Open circuit photovoltage (OCPV) measurements made on one cell (372-5) are shown in Figure 12 and indicate substantial variations in diffusion lengths versus position on a single cell 1cm^2 in area. These results indicate that gettering is occurring during processing since substrate diffusion lengths of $10\mu\text{m}$ were typical prior to processing while $10 - 50\mu\text{m}$ diffusion lengths result after processing. The diffusion lengths observed in certain regions are very respectable. OCPV diffusion lengths as high as $77\mu\text{m}$ have been measured on other samples. Of interest are the large diffusion lengths occurring even directly over grain boundaries, but low diffusion lengths over macroscopically smooth areas. A study which will correlate these diffusion length spatial measurements with microscopic structure as delineated by Wright etching is in progress. A correlation between OCPV measurements and SPV measurements on the substrates after etch removal of the junction will also be performed.

5.1.3 SOLAR CELL EVALUATIONS: Lot #2

The latest batch of ribbon solar cells was incorrectly processed during the diffusion step, resulting in poor (electrical) isolation between solar cells adjacent to one another on the ribbon. Because of this, the devices in this group may not be typical of ribbon cells. An attempt was made to compensate for the lack of isolation by scribing and separating each individual device, and measurements were taken on several cells before and after separation for comparison. After separation, there was a slight increase in V_{OC} (1.4% averaged over 7 samples) and a drop in I_{SC} (19%) except for one sample (495-7) which showed no change. This sample was probably suitably isolated before scribing. The drop in I_{SC} (and increase in V_{OC}) can be accounted for by the

FIGURE 12 OCPV Diffusion Lengths As
a Function of position for
sample 372-5.



E3475A

reduction in area after scribing. The extra post-diffusion handling test this group was subjected to does not appear to have seriously degraded their performance.

There were 42 solar cells of the following types:

<u>NUMBER OF CELLS</u>	<u>TYPE</u>	<u>COMMENTS</u>
4	Normal control cells	1 with bad front contact; average efficiency of the other 3 was 7.6% (AM1)
1	Ribbon control cell	$\eta = 9\%$
7	$\frac{1}{2}$ on ribbon - $\frac{1}{2}$ off	
4	Ribbon cells	Bad front contacts
27	Ribbon cells	Average $V_{OC} = .41$ volts $J_{SC} = 24. \text{mA/cm}^2$ $\eta = 5.3\%$ (AM1)

This batch of ribbon cells was characterized by high leakage current resulting in poor fill factors and open-circuit voltages. The short-circuit currents were typical of previously reported ribbon solar cells. The highest efficiency cell found was 9.5% (494-7) under approximately AM1 illumination.

Spectral response measurements, when compared with a NASA terrestrial standard n+ - p cell (See Figure 13), reveal the greatest loss in J_{SC} is in the visible part of the spectrum. Since the visible light is absorbed in the first 10 - 20 micrometers, it is clearly not the ribbon material's diffusion length that is responsible. More likely this loss in J_{SC} is due to an unusually deep diffusion or possibly the presence of a damaged surface region; e.g., the "wrong" side of a one-side irradiated sample may have been processed, although this is unlikely. The resulting degraded lifetime could also be responsible for the high leakage currents observed for these devices. If the damage present in the n+ region extends into the space charge region,

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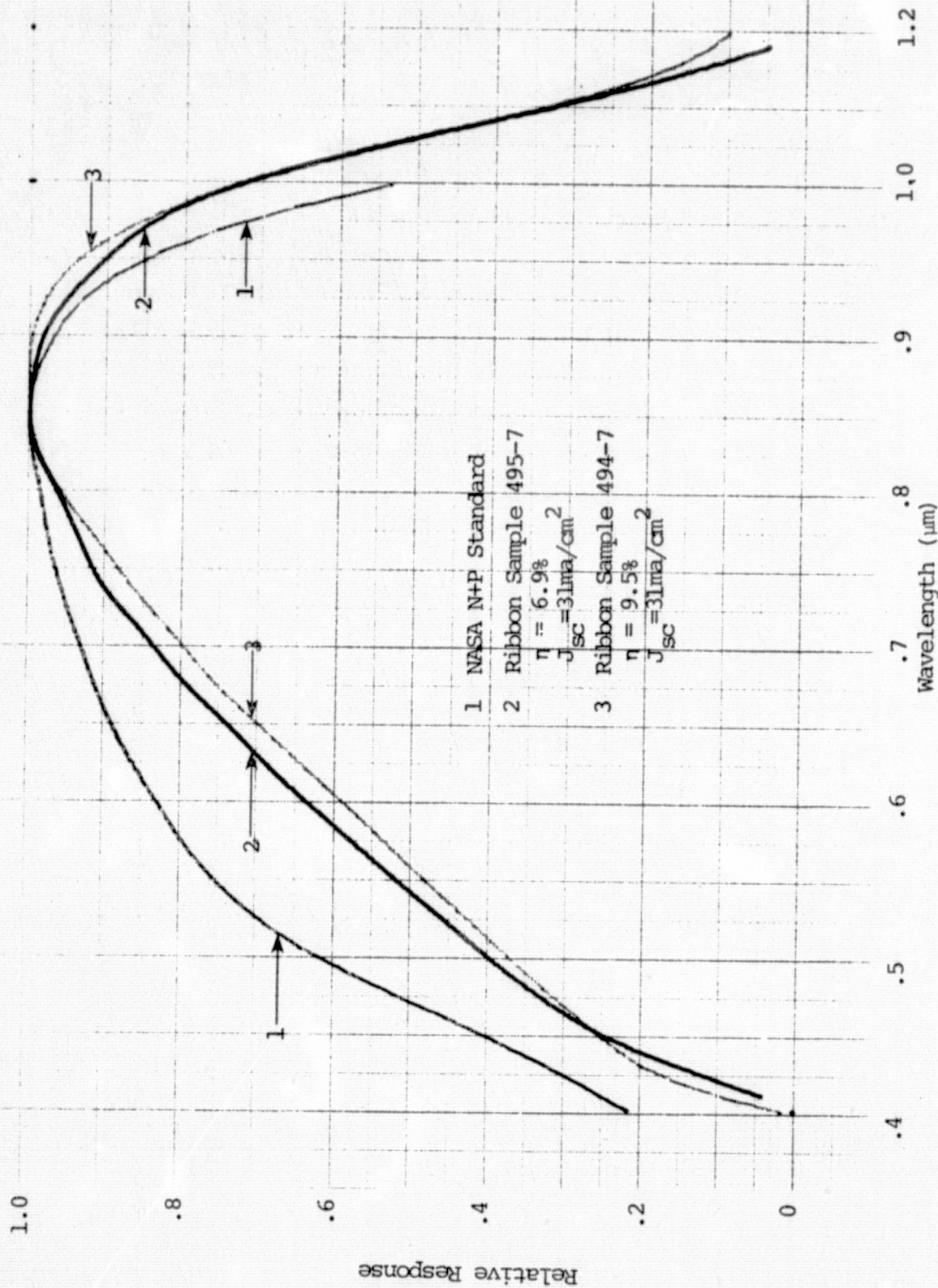


Figure 13: Comparative Spectral Response Curves for a NASA Standard Cell and Two Ribbon Solar Cells

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then excessive recombination current (which is proportional to $\frac{1}{\tau}$) will be present under forward bias. The simple fact that the control cells exhibited an average efficiency of 7.6% (compared to 12.66% for the first lot) clearly indicates some major processing error.

The spectral response in the near infrared, where the penetration of the light extends for over 100 micrometers into the substrate, indicates a sharper drop off for a ribbon cell than for the NASA standard. This is due to the shorter diffusion length in the ribbon material.

6.0 ECONOMIC ANALYSIS

An initial economic analysis of the RTR growth process has been performed. This economic analysis is based upon extrapolating the capabilities of our present 400 watt laser/crystal growth system to a number of higher power laser/crystal growth systems. This analysis will need to be updated when we have accumulated experience working with the higher power lasers.

6.1 ECONOMIC DATA BASE

This economic analysis is based upon the following data. These figures are presently being used throughout Motorola for its own in-house analysis. CAPITAL: The capital cost of equipment is depreciated over a seven-year period. The capital cost of a factory building is depreciated over 40 years. The interest rate on both capital and factory is assumed to be 9% per annum.

The factory floor space is assumed to be 70% for production, 30% for support offices, warehouse, cafeterias, etc. Construction cost for production space is \$80/sq. ft. and for support space \$30/sq. ft. Thus each sq. ft. of production space will cost \$92.95. The overhead costs on the factory include taxes and insurance at 5%/year = \$4.65/sq. ft. yr.,

electricity at \$1.36/sq. ft. yr., water at \$0.06/sq. ft. yr. and miscellaneous items at \$0.45/sq. ft. yr.

LABOR: The direct labor cost is estimated at \$5.96/hour. This includes the cost of utility operators, employee instruction time, set-up time, clean-up time, coffee breaks, rest-room time, material handling and transfer and data compilation. Also included are the employee's fringe benefits, i.e., vacation, retirement, insurance, F.I.C.A., cafeteria, unemployment taxes, credit union, employee sales, and recreation activities.

The overhead on labor includes 18% for supervisors, 3.8% for engineers, 3.7% material support, 1.5% quality assurance, and 5.4% sustaining engineering. Thus the total labor cost is \$7.95/hr.

ELECTRICITY: The cost of electricity is assumed to be \$219/KW-year. The total electrical cost is given by:

$$El. Cost = [0.5A + B + 0.4C] (\$219/KW\text{-year})$$

where

(6-1)

A. = (Number of Machines) (Power Consumption) (Utility Factor)

is the cost of the electricity directly consumed by each piece of equipment.

$$B. = (\text{exhaust in CFM}) \left(\frac{0.46KW}{10000CFM} \right)$$

is the power consumed by exhaust systems

$$C. = \frac{A}{8} + \frac{15 KW}{1000 CFM}$$

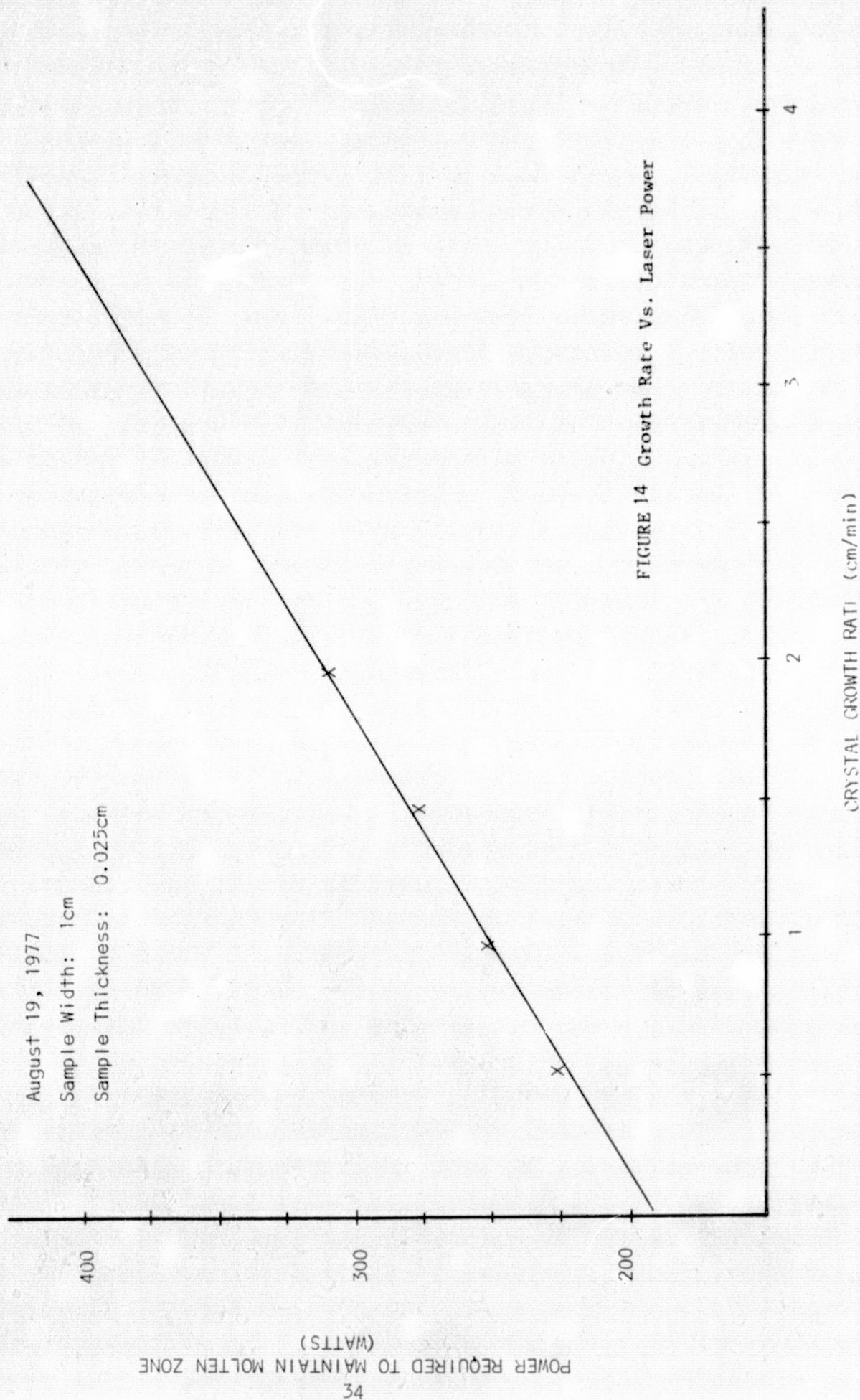
is the power consumed in air-conditioning the building.

The coefficients before A and C in equation (6-1) reflect the percentage of the year during which these electrical loads are being used.

6.2 ADD-ON COST PROJECTION

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In order to estimate the production capability of a high-power (2 - 3KW) laser, a graph of power required vs. growth rate was obtained (See Figure 14).



Assuming that the linear relationship shown in Figure 14 holds when we extrapolate to higher powers, we can write:

$$P = WT(P_0 + cv)$$

where P = laser power required (watts)

W = ribbon width (cm)

T = ribbon thickness (cm)

P_0 = power required to melt a stationary ribbon (watts)

v = growth rate (cm/min)

c = coefficient obtained from the slope in Figure 14

Assuming hemispherical reflectors are used to essentially double the laser coupling efficiency, $C = 9.1 \text{ watts} - \text{min}/\text{cm}^3$. Thus the production capacity per year is given by:

$$\text{PCAP} = N (6 \times 10^{-3}) (5400) \left[\frac{P \times 10^{-2} - 30 W T}{(9.2) T} \right] \quad (6.2)$$

$\text{M}^2 \text{ of Si/Year}$

The factors $(6 \times 10^{-3}) (5400)$ are due to the change in units from cm^2/min to M^2/year . A Motorola production facility working three shifts/day, has 5400 operating hours/year.

Two more factors must be included: a utilization factor (U) to account for down time due to maintenance, etc., and a quality (Q) factor since not all the ribbon produced will necessarily be useable. So we have:

$$\text{PCAP} = N U Q \left[\frac{P \times 10^{-2} - 30 W T}{(9.2) T} \right] (6 \times 10^{-2}) (5400) \quad (6.3)$$

M^2/Year

The largest single capital item, of course, is the laser. Since the larger size CO_2 lasers are being produced only in limited numbers, their price now is relatively high. However, we obtained an informal estimate of \$75,000/ea for 3KW CO_2 lasers based on ordering ten systems for delivery in 1980. This is the laser cost used in this study. From, Table V, we can see that, for example at 20cm/min. growth rate, with 10cm wide ribbon, a dozen

lasers would produce $\sim 56,000 \text{ M}^2/\text{year}$, which is roughly a 6 megawatt production capability. Since the ERDA estimate of the 1982 market is 25 - 50 megawatts, this is a conservative estimate for the size of a single factory. If the 1986 ERDA 500 megawatt capability is used, then the CO_2 lasers would be ordered in much greater numbers, and their price would be drastically reduced.

Table V tabulates the parameters assumed for an RTR production facility. Use of table V in conjunction with equations 6.1 and 6.3 allow calculation of the RTR add-on costs for various rates and ribbon widths. The results of these calculations are shown in Table VI. The laser power required, column 3, is calculated from eq. 6.1 for a given ribbon width, thickness, and growth rates (since the laser is assumed to be operating at $\sim 90\%$ of full power, the laser power values listed in column 3 are 10% higher than the powers calculated strictly from eq. 5.1). The utility factor was assumed to be 0.8, and the quality factor ≈ 0.9 . The results shown in Table V do not assume the use of a pre-heater on the preformed silicon ribbon. If a pre-heater can be used to raise the temperature of the incoming ribbon to $\sim 1200 - 1400^\circ\text{C}$, then the required laser power would be strongly reduced, and the overall cost would be lowered significantly.

We anticipate a maximum growth rate in the range of 10 - 20 cm/min. Note that, at constant growth rate, the cost is significantly reduced as a function of sample width. The add-on cost is projected to range from 22¢/watt for 10cm/min, 6cm wide ribbon to 7¢/watt for 25cm/min, 12cm wide ribbon.

We emphasize that these cost projections are really premature. When we have established a firm data base by working with the 1.5kw CO_2 laser, we will repeat these calculations with a much higher confidence level.

TABLE V

ASSUMPTION USED TO CALCULATE PROJECT RTR ADD-ON COST

Total Area/Growth Station: 500 sq. ft. plus *

Laser Cost: \$25/watt output power

Labor: One operator per 6 machines

Growth Apparatus:

Table w/enclosure	7K
Transport Mechanism	5K
Motors	3K
TV Cameras and Monitors	1K
Optical Components	2K
(Capital)	
Scanning System	6K
Automatic Control System	5K

Consumable Items:

H ₂ : 3scfH	
N ₂ : 25scfH	
Optical Components	2K
(annual replacement cost)	

Power Consumption: The lasers efficiency was assumed to be 4%. The auxiliary heaters, motors and other equipment were scaled to the laser power consumption, i.e., the total power consumption is 130% of the laser power consumption.

* A slightly higher area was used for lasers larger than 2000 watts.

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TABLE VI
ADD-ON COST PROJECTION FOR RTR SILICON

(Assuming 12 growth systems, 0.01cm thick ribbon, and 11% encapsulated solar cell efficiency.)

GROWTH RATE (cm/min)	WIDTH (cm)	LASER POWER REQUIRED watts	PRODUCTION CAPACITY (m ² /yr)	\$/m ² SILICON	COST PROJECTION \$/WATT
10	6	805	16,796	24.6	0.223
10	8	1074	22,395	19.6	0.178
10	10	1342	27,994	16.6	0.150
10	12	1610	33,592	14.6	0.132
15	6	1109	25,194	17.5	0.159
15	8	1478	33,592	14.2	0.129
15	10	1848	41,990	12.2	0.111
15	12	2218	50,388	10.8	0.099
20	6	1412	33,592	14.0	0.127
20	8	1883	44,790	11.5	0.104
20	10	2354	55,987	10.0	0.091
20	12	2825	67,184	9.0	0.082
25	6	1712	41,990	11.9	0.108
25	8	2288	55,987	9.9	0.090
25	10	2860	69,984	8.7	0.079
25	12	3432	83,981	7.9	0.072

7.0 PROBLEMS

Problems experienced to date have been the many delays in completion of the facilities for the new laboratory. These delays, together with excessive time for fabrication and acquisition of components for the new system, have seriously delayed the RTR #2 development.

Problems have also occurred on RTR #1. The linear profile furnace was down for some time due to loss of a few heater elements, and this resulted in some lost time. The beam scanning systems have also required factory repairs, due possibly to overheating. For some time, only one beam scanner was available.

8.0 PLANS

Completion of the new laser lab will occur early in this next quarter. RTR #1 will be operated with the new lasers and high speed scanners as soon as possible. The CO₂ and Nd:YAG lasers will be compared to determine which system will be retained.

Material and device analysis will continue on an increased scale to improve our understanding of material quality and to optimize device performance. Increased emphasis on impurity and structural analysis will be used in attempts to eliminate factors which presently limit material quality.

9.0 NEW TECHNOLOGY

No new technology items were uncovered during the report period.

10.0 PROGRAM PLAN/MILESTONES

Activities associated with the total program are shown in the Program Plan/Milestone charts contained in Appendix I.

11.0 ENGINEERING DRAWINGS

Drawings of the improved transport stage and preliminary drawings of components for the RTR apparatus are contained in Appendix 11.

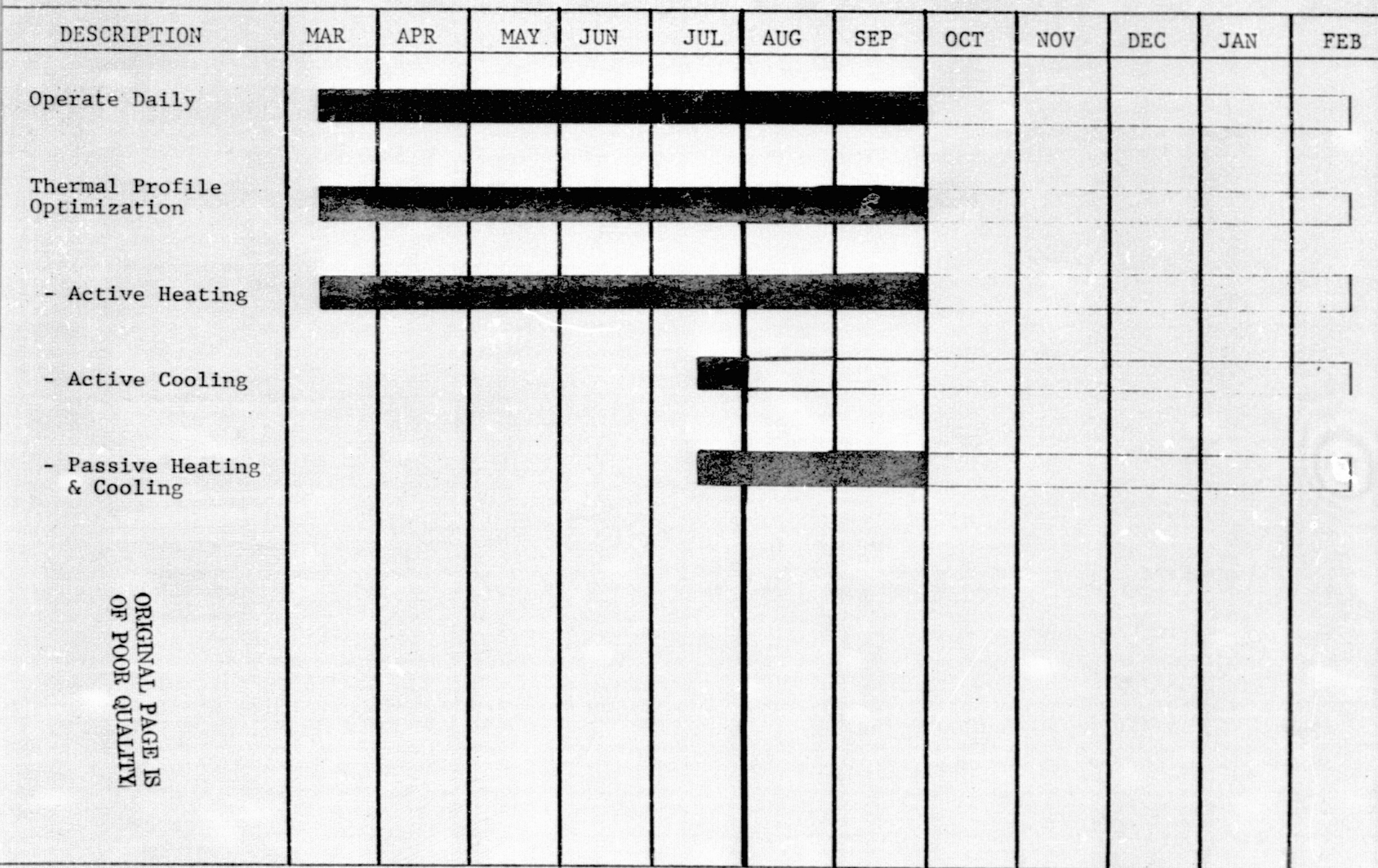
APPENDIX I

Program Plan/Milestone Chart

WORK BREAKDOWN SCHEDULE NO.1

Model 1 RTR Apparatus

MOTOROLA PROJECT NO. 2319



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FIGURE 1

PROGRAM PLAN/MILESTONE CHART

LEGEND 

SCHEDULED 

COMPLETED

 DELIVERY SCHEDULE

 DELIVERED

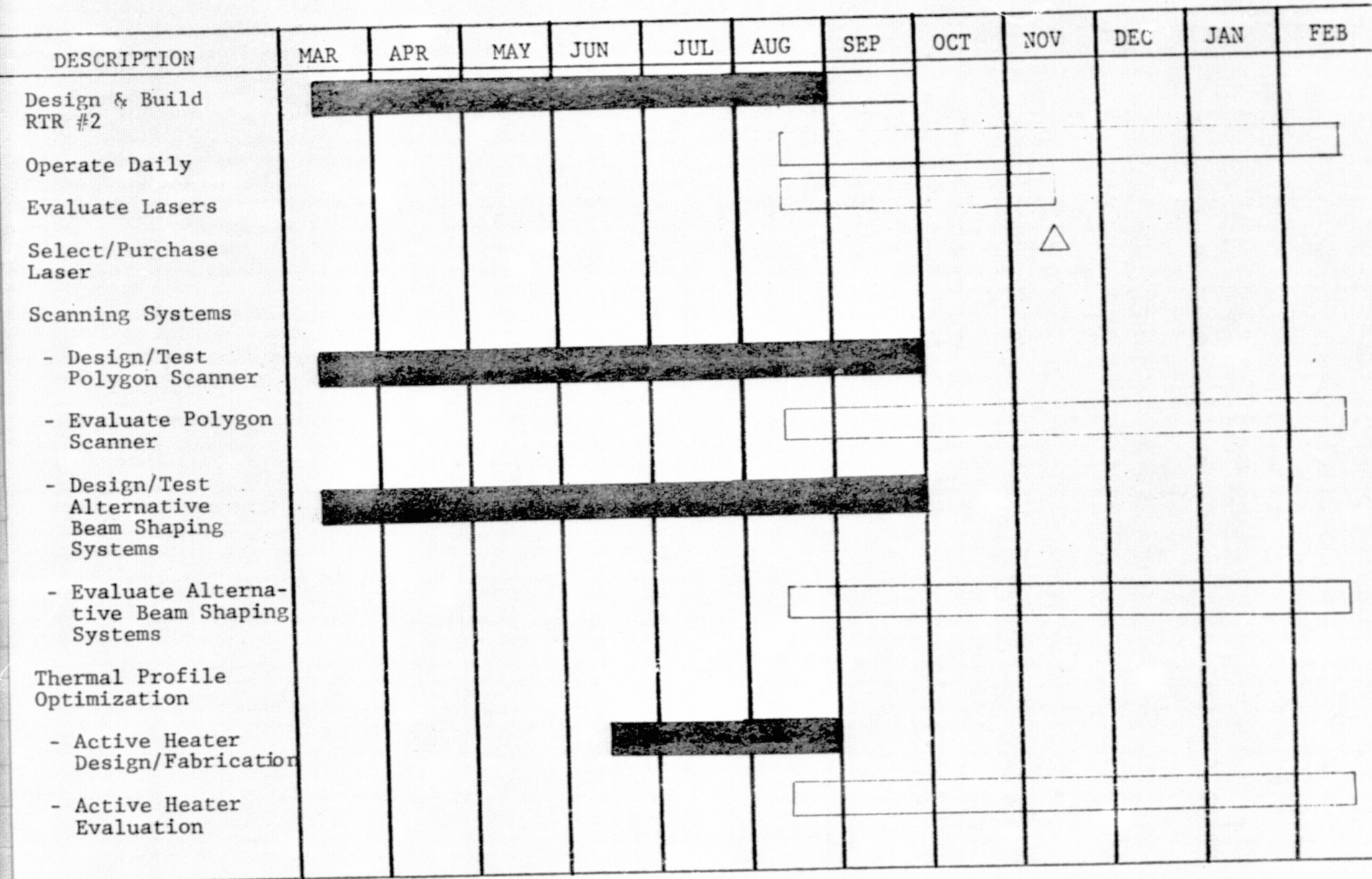
Model 2 RTR Apparatus

FIGURE 2

PROGRAM PLAN/MILESTONE CHART

LEGEND 

SCHEDULED

COMPLETED

 DELIVERY SCHEDULE DELIVERED

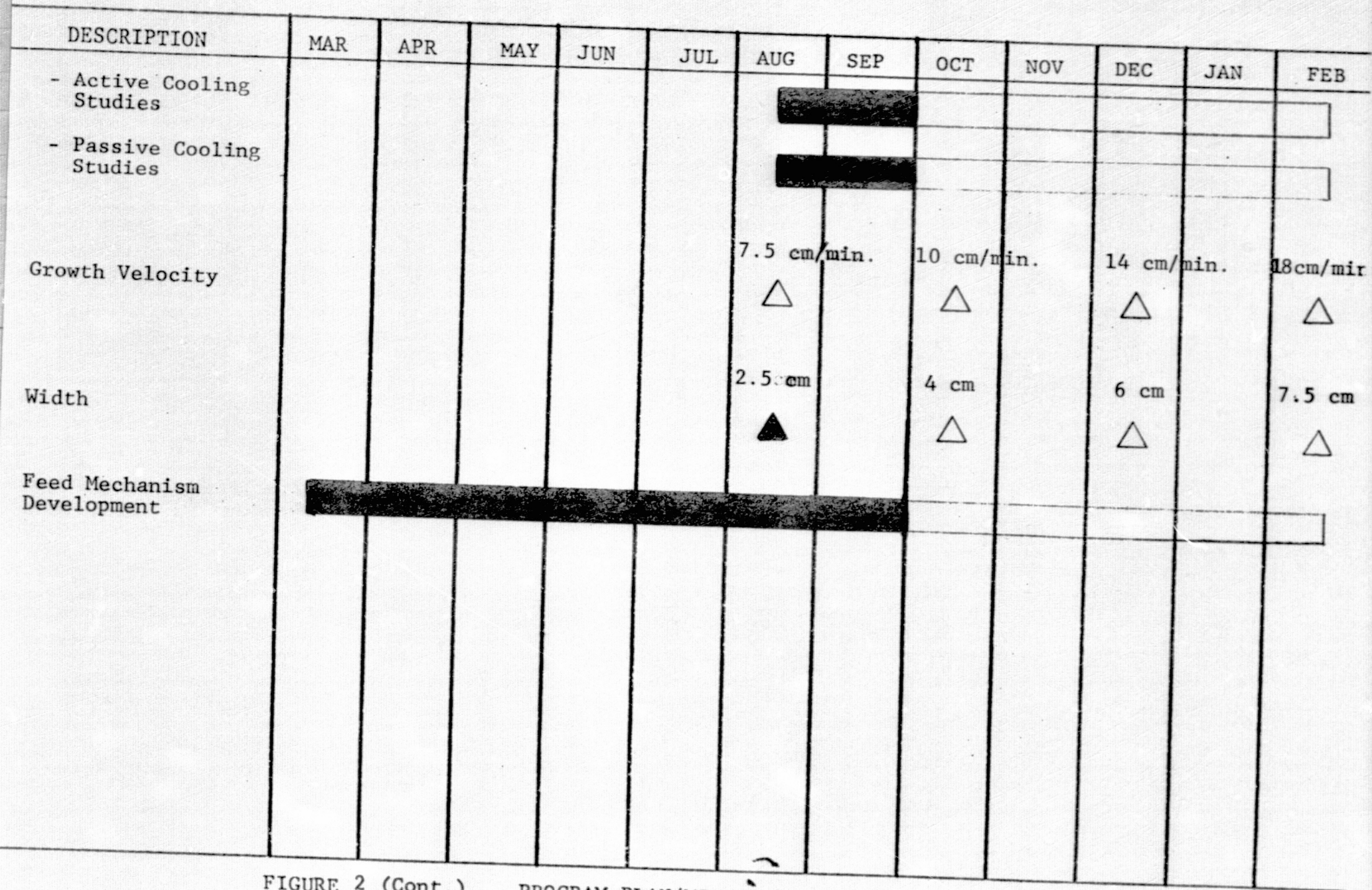


FIGURE 2 (Cont.)

PROGRAM PLAN/MILESTONE CHART

LEGEND SCHEDULED 

COMPLETED

 DELIVERY SCHEDULE DELIVERED

Thermal Stress Analysis

DESCRIPTION	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB
Computer Code for Ribbon Thermal Analysis												
Theoretical Modeling of Growth Interfaces and Stresses												
Experimental Stress Analysis vs, Growth Parameters												

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Ribbon Characterization

MOTOROLA PROJECT NO. 2322

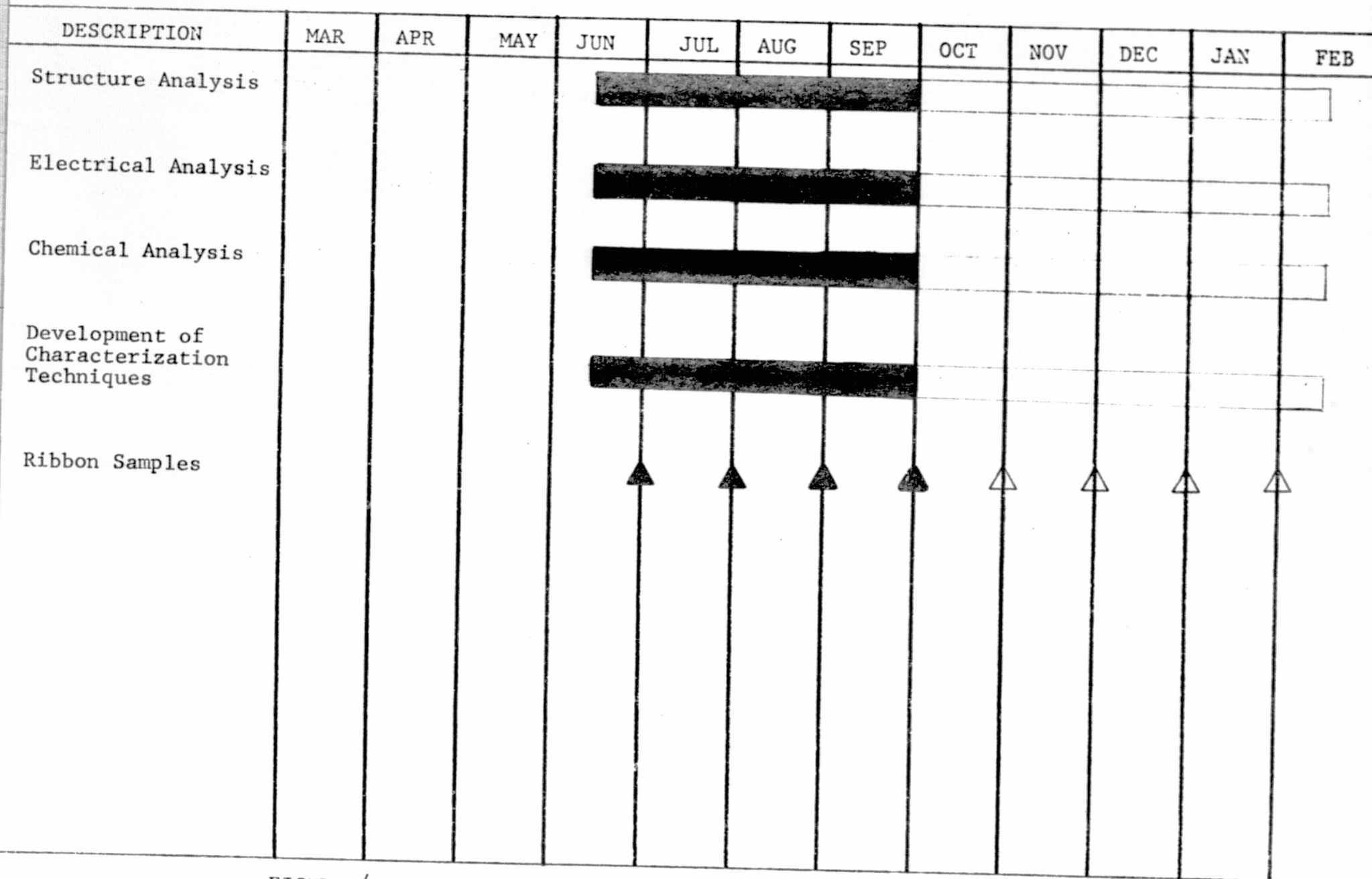


FIGURE 4

PROGRAM PLAN/MILESTONE CHART

LEGEND SCHEDULED 

COMPLETED

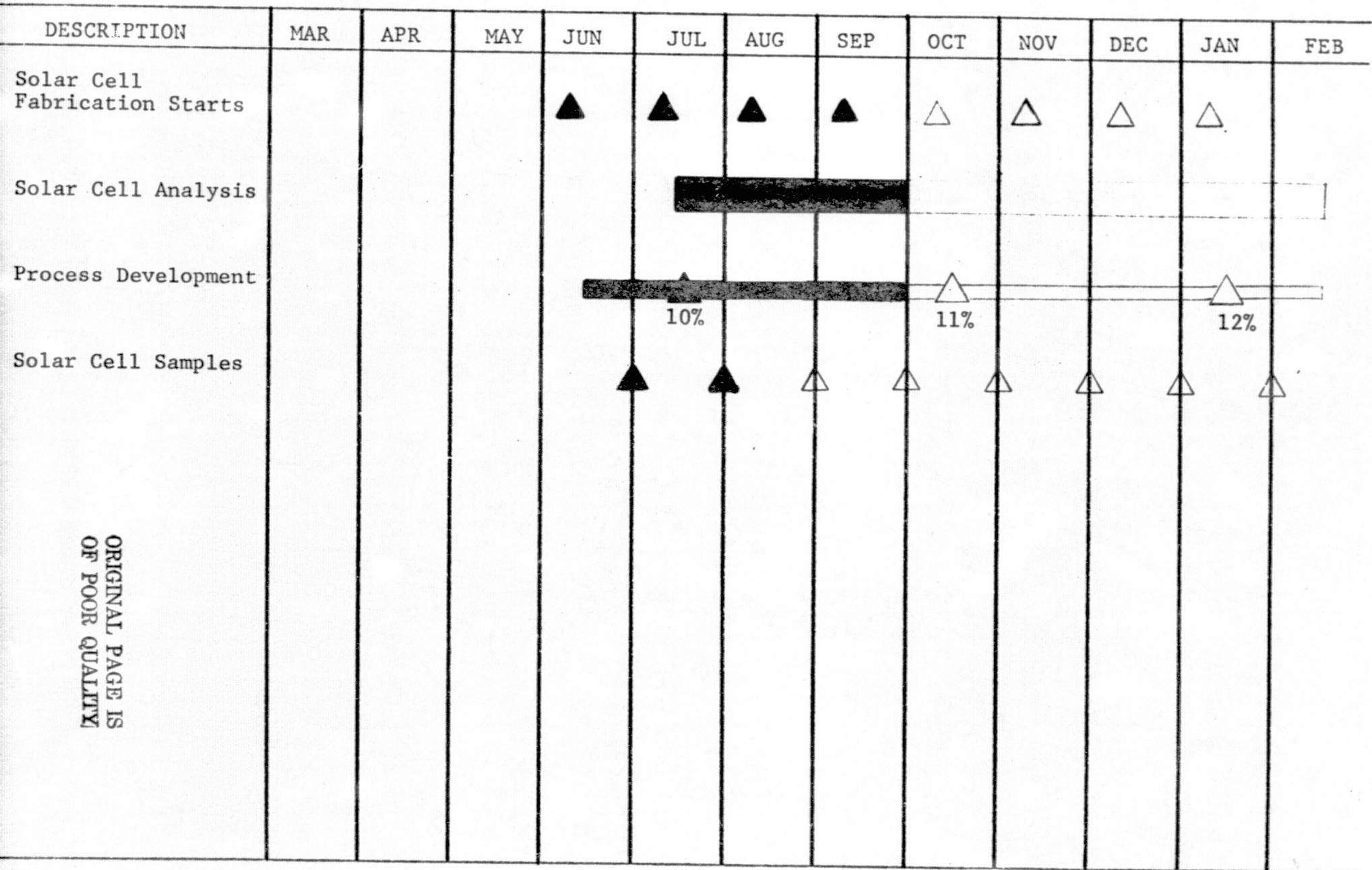
△ DELIVERY SCHEDULE

▲ DELIVERED

WORK BREAKDOWN SCHEDULE NO. 5

Solar Cell Dev. Fab and Testing

MOTOROLA PROJECT NO. 2323



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FIGURE 5

PROGRAM PLAN/MILESTONE CHART

LEGEND  SCHEDULED  COMPLETED

 DELIVERY SCHEDULE

 DELIVERED

WORK BREAKDOWN SCHEDULE NO. 6

MOTOROLA PROJECT NO. 2324

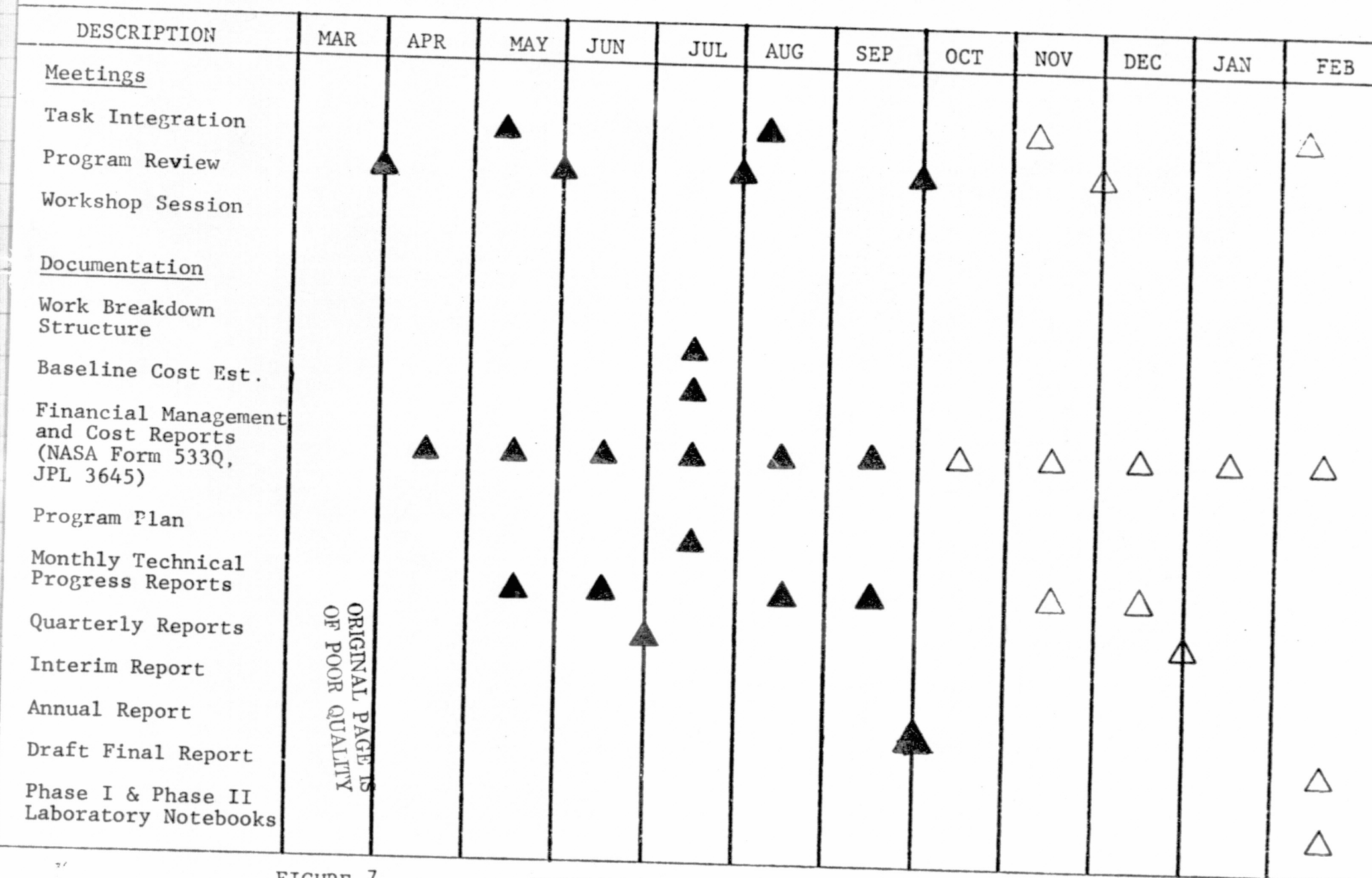
Economic Analysis

DESCRIPTION	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB
Economic Analysis of RTR Growth												

WORK BREAKDOWN SCHEDULE NO. 7

Program Management and Documentation

MOTOROLA PROJECT NO. 2325



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FIGURE 7

PROGRAM PLAN/MILESTONE CHART

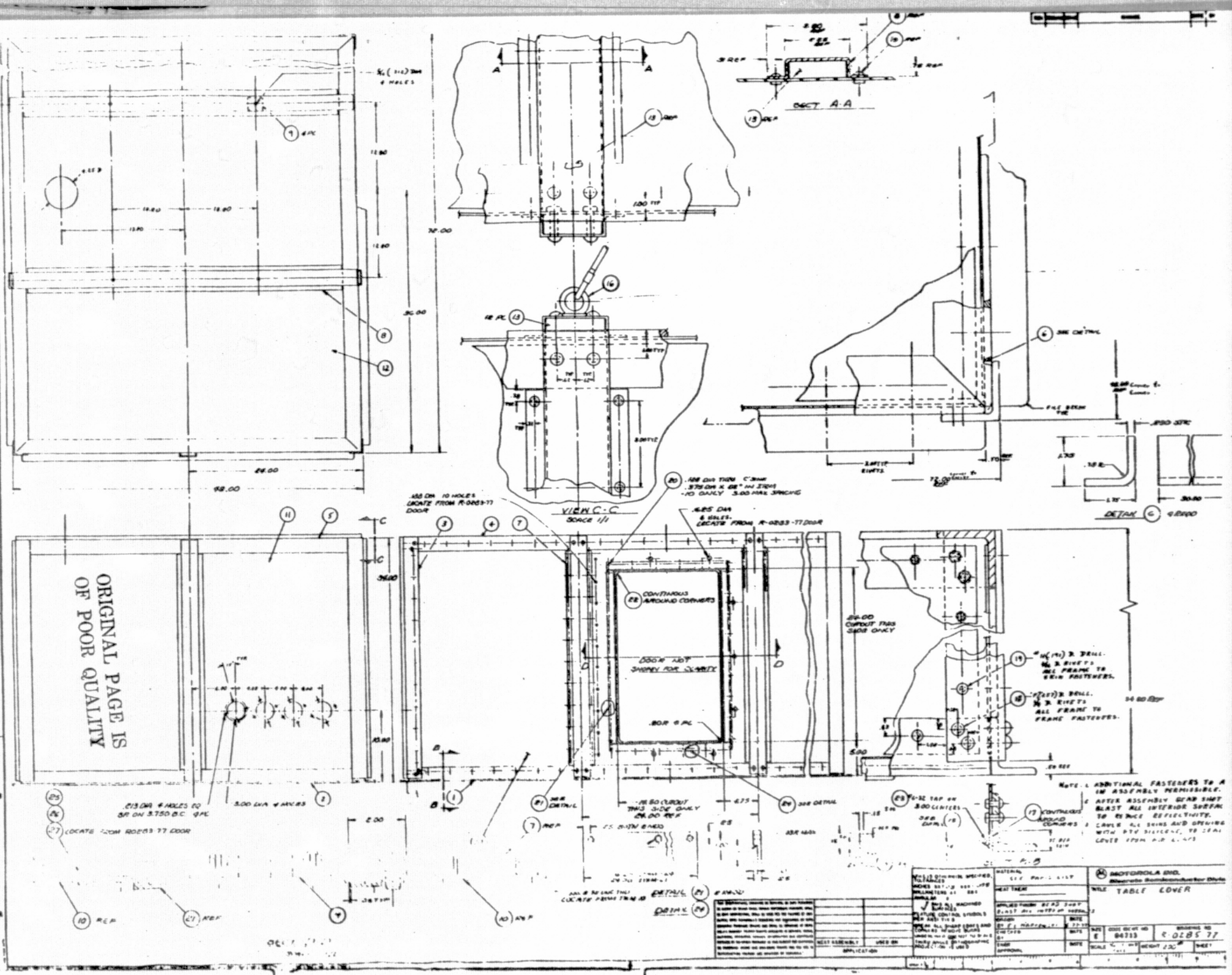
LEGEND  SCHEDULED  COMPLETED

 DELIVERY SCHEDULE

 DELIVERED

APPENDIX II

Engineering Drawings



MATERIAL SPECIFICATIONS		MATERIAL SPECIFICATIONS	
ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION
1	TABLE COVER	2	TABLE COVER
3	TABLE COVER	4	TABLE COVER
5	TABLE COVER	6	TABLE COVER
7	TABLE COVER	8	TABLE COVER
9	TABLE COVER	10	TABLE COVER
11	TABLE COVER	12	TABLE COVER
13	TABLE COVER	14	TABLE COVER
15	TABLE COVER	16	TABLE COVER
17	TABLE COVER	18	TABLE COVER
19	TABLE COVER	20	TABLE COVER
21	TABLE COVER	22	TABLE COVER
23	TABLE COVER	24	TABLE COVER
25	TABLE COVER	26	TABLE COVER
27	TABLE COVER	28	TABLE COVER
29	TABLE COVER	30	TABLE COVER
31	TABLE COVER	32	TABLE COVER
33	TABLE COVER	34	TABLE COVER
35	TABLE COVER	36	TABLE COVER
37	TABLE COVER	38	TABLE COVER
39	TABLE COVER	40	TABLE COVER
41	TABLE COVER	42	TABLE COVER
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75	TABLE COVER	76	TABLE COVER
77	TABLE COVER	78	TABLE COVER
79	TABLE COVER	80	TABLE COVER
81	TABLE COVER	82	TABLE COVER
83	TABLE COVER	84	TABLE COVER
85	TABLE COVER	86	TABLE COVER
87	TABLE COVER	88	TABLE COVER
89	TABLE COVER	90	TABLE COVER
91	TABLE COVER	92	TABLE COVER
93	TABLE COVER	94	TABLE COVER
95	TABLE COVER	96	TABLE COVER
97	TABLE COVER	98	TABLE COVER
99	TABLE COVER	100	TABLE COVER

NOTE: UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN INCHES.

1.25 R TYP
4PLS

3.75

1.35

1.75

1.05

.88

.35 TYP

.08 TYP

.14 TYP

.85 TYP

.68 TYP

.115 TYP

.30 TYP

.46 TYP

1.57 TYP

1.300 TYP

1.22 TYP

2.00 TYP

.375 DIA, THRU

DRILL & TAP FOR *

1927

NEXT ASSEMBLY	USED ON
APPLICATION	

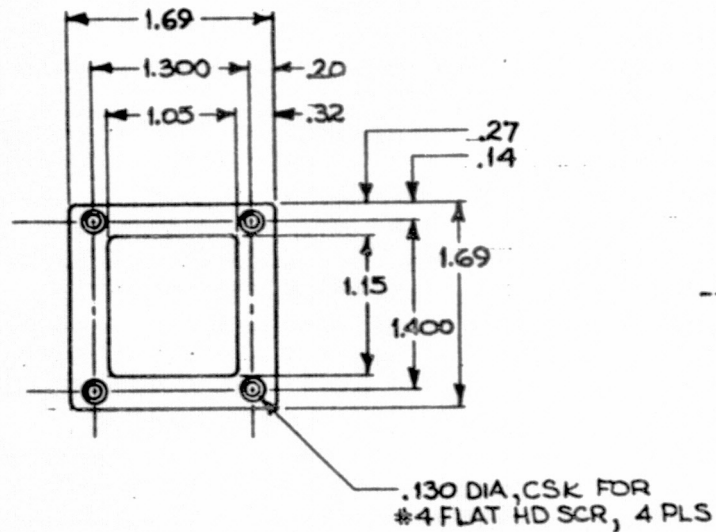
UNLESS OTHERWISE SPECIFIED
TOLERANCES
DIMENSIONS XX.X, .XX, .XXX, .005
DIMENSIONS XX.XX, .XX, .XXX, .005
ANGULAR ±
6.3 RMS ALL MACHINED
SURFACES
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5
BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.
UNDEVELOPED DO NOT TO SCALE
THINABLE ORTHOGRAPHIC
PROJECTION IS USED.

MATERIAL		.75 THK
HALF HARD BRASS		
HEAT TREAT		
APPLIED FINISH		
GRAIN	F.J MOSNA	DATE
BY		F-1
CHECKED		DATE
BY		
REWORK		DATE
BY		

 MOTOROLA INC. Discrete Semiconductor Division			
TITLE: COOLING BLOCK- LENS (1x1) POLYGON SCANNER			
SIZE C	CODE IDENT. NO. 04713	DRAWING NO R-0272-77-31	
SCALE FULL	WEIGHT	SHEET 1 OF	

REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY

ORIGINAL PAGE IS
OF POOR QUALITY



NOTE- ALL RADII .06

2 R.D

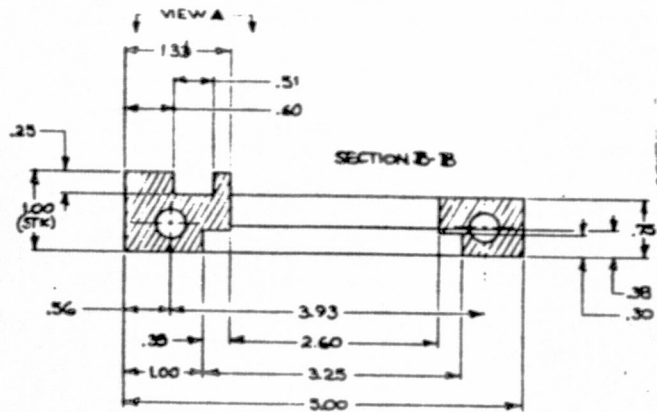
"ANY SPECIFICATIONS, DRAWINGS OR REPORTS, OR DATA FURNISHED TO BIDDER OR SELLER SHALL REMAIN MOTOROLA'S PROPERTY, SHALL BE KEPT CONFIDENTIAL, SHALL BE USED FOR THE PURPOSE OF COMPLYING WITH MOTOROLA'S REQUESTS FOR QUOTATION OR WITH MOTOROLA PURCHASE ORDERS AND SHALL BE RETURNED AT MOTOROLA'S REQUEST. PATENT RIGHTS SUGGESTED IN DESIGNS, TOOLS, PATTERNS, DRAWINGS, DEVICES, INFORMATION AND EQUIPMENT SUPPLIED BY MOTOROLA PURSUANT TO THIS REQUEST FOR QUOTATION OR PURCHASE ORDER AND EXCLUSIVE RIGHTS FOR THE USE OR REPRODUCTION THEREOF ARE RESERVED BY MOTOROLA."

UNLESS OTHERWISE SPECIFIED, TOLERANCES: INCHES .XX ± .02 .XXX ± .005 MILLIMETERS .X ± .XX ± .X ANGULAR ± ✓ RMS ALL MACHINED SURFACES. FEATURE CONTROL SYMBOLS PER ANSI Y14.5. BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS. UNDERLINED DIM NOT TO SCALE. THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.		MATERIAL .062 THK HALF HARD BRASS		MOTOROLA INC. Discrete Semiconductor Division TITLE: BEZEL-COOLING BLOCK LENS (1x1)		
		HEAT TREAT				
		APPLIED FINISH		SIZE B		CODE IDENT. NO. 04713
		DRAWN BY F.J. MOSNA		DATE 7-13-77	DRAWING NO. R-0272-77-32	
CHECKED BY		DATE	SCALE FULL		WEIGHT	
ENGR. APPROVAL		DATE	SHEET 1		OF 1	

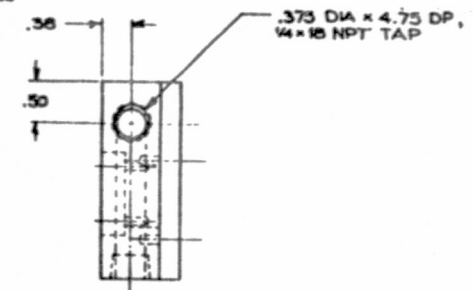
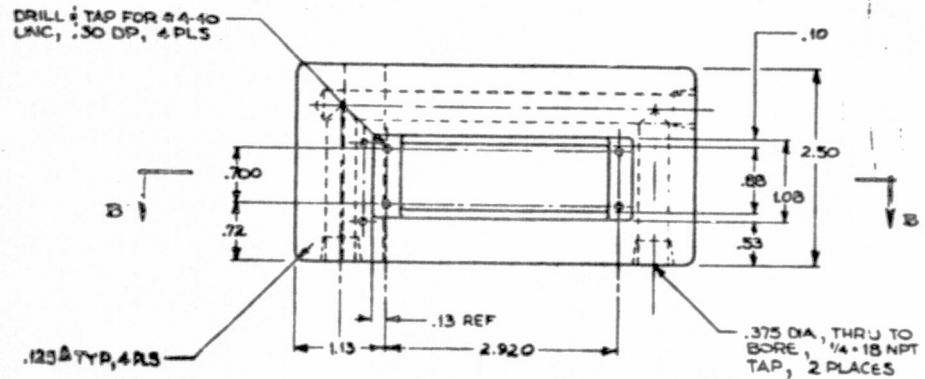
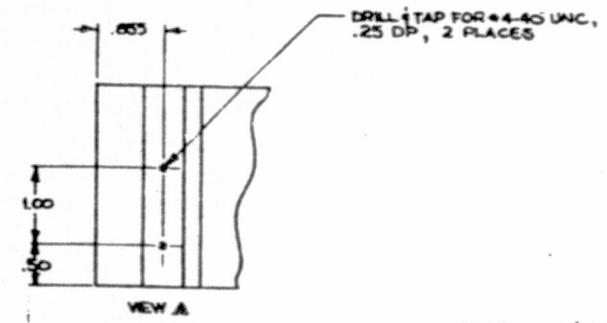
NEXT ASSEMBLY USED ON

APPLICATION





NOTE: ALL RADII .062 MAX UNLESS OTHERWISE SPECIFIED



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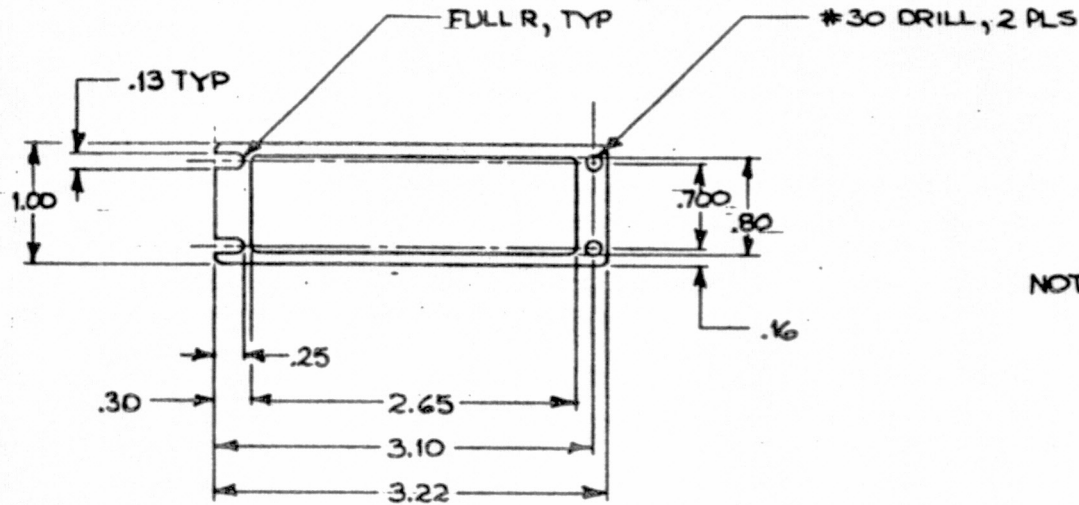
DATE	BY	DESCRIPTION

UNLESS OTHERWISE SPECIFIED, TOLERANCES:
 DECIMALS: .XX ± .02 XXX ± .005
 MILLIMETERS: .XX ± .05
 ANGULAR: ± .5°
 SURFACES: 4.3 RMS ALL MACHINED SURFACES
 FEATURE CONTROL SYMBOLS PER ANSI Y14.5
 BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.
 UNDERLINED DIM NOT TO SCALE
 THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

MATERIAL: 1.00 THK WAFER HARD BRASS
 HEAT TREAT: ☐
 APPLIED FINISH: ☐
 DRAWN BY: F.J. MOSNA
 CHECKED BY: ☐
 DATE: 7-14-77

MOTOROLA INC. Discrete Semiconductor Division	
TITLE: COOLING BLOCK - LENS (2.5x1) POLYGON SCANNER	
SIZE: C	CODE IDENT. NO.: 04713
DRAWING NO.: R-0272-77-33	SHEET 1 OF 1

REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY ENGR.



NOTE - ALL RADII .062

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NEXT ASSEMBLY

USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED,
TOLERANCES:

INCHES .XX ± .02 .XXX ± .005

MILLIMETERS .X ± .XX ± .XX ±

ANGULAR ±

✓ RMS ALL MACHINED SURFACES.

FEATURE CONTROL SYMBOLS PER ANSI Y14.5.

BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.

UNDERLINED DIM NOT TO SCALE

THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

MATERIAL .031 THK
HALF HARD BRASS

HEAT TREAT

APPLIED FINISH

DRAWN BY F.J. MOSNA DATE 7-14-77

CHECKED BY DATE

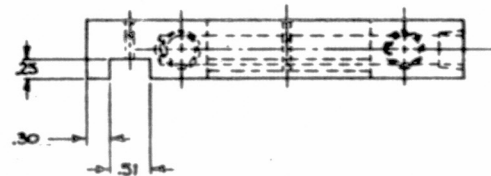
ENGR. APPROVAL DATE

MOTOROLA INC.
Discrete Semiconductor Division

TITLE:
COOLING BLOCK - LENS (2.5x1)
BEZEL

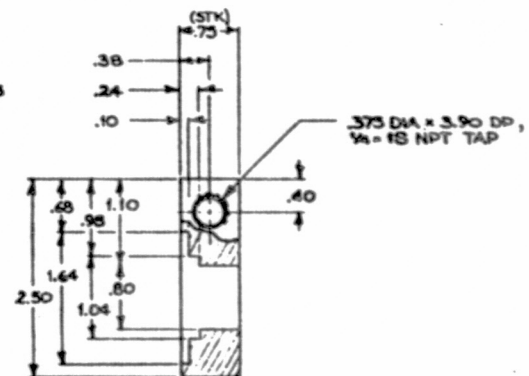
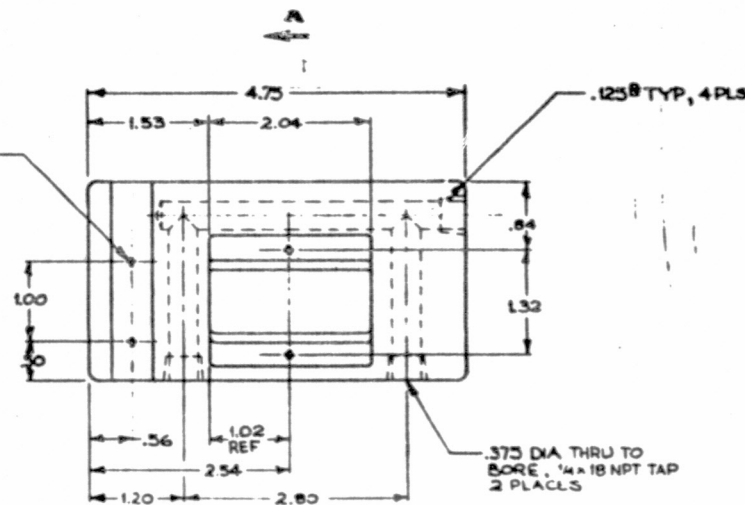
SIZE	CODE IDENT. NO.	DRAWING NO.
B	04713	R-0272-77-34
SCALE FULL	WEIGHT	SHEET 1 OF 1





NOTE- ALL RADII .062 MAX
UNLESS OTHERWISE SPECIFIED

DRILL & TAP FOR
6-40 UNC, 4 PLS
THRU



SECTION A-A

1 REQ'D

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APPLICATION

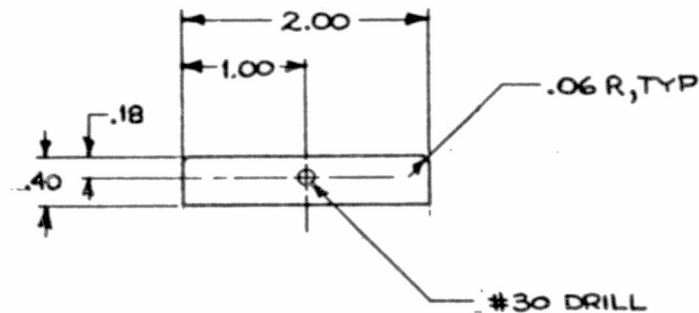
UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES XX ± .02 XXX ± .005
MILLIMETERS X1 ± .XX ± .1
ANGULAR ±
3/ RNS ALL MACHINED
SURFACES
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5
BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED

MATERIAL .75 THK
HALF HARD BRASS
HEAT TREAT
APPLIED FINISH
DRAWN F.J. MOSNA
CHECKED BY
DATE 7-15-77
DATE

MOTOROLA INC.
Discrete Semiconductor Division
TITLE:
COOLING BLOCK-LENS (2.0x1)
POLYGON SCANNER
SIZE CODE BENT NO
C 04713
DRAWING NO
R-0272-77-35
SCALE FULL WEIGHT SHEET 1 OF 1



REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY ENGR.



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4
2 REQ'D

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NEXT ASSEMBLY

USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED,
TOLERANCES:

INCHES .XX ± .02 .XXX ± .005

MILLIMETERS .X ± .XX ±

ANGULAR ±

✓ RMS ALL MACHINED SURFACES.

FEATURE CONTROL SYMBOLS PER ANSI Y14.5.

BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.

UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

MATERIAL

.03 THK
HALF HARD BRASS

HEAT TREAT

APPLIED FINISH

DRAWN BY F.J. MOSNA

DATE 7-15-77

CHECKED BY

DATE

ENGR. APPROVAL

DATE



MOTOROLA INC.

Discrete Semiconductor Division

TITLE:

COOLING BLOCK - LENS (2.0x1)
BEZEL

SIZE

B

CODE IDENT. NO.

04713

DRAWING NO.

R-0272-77-36

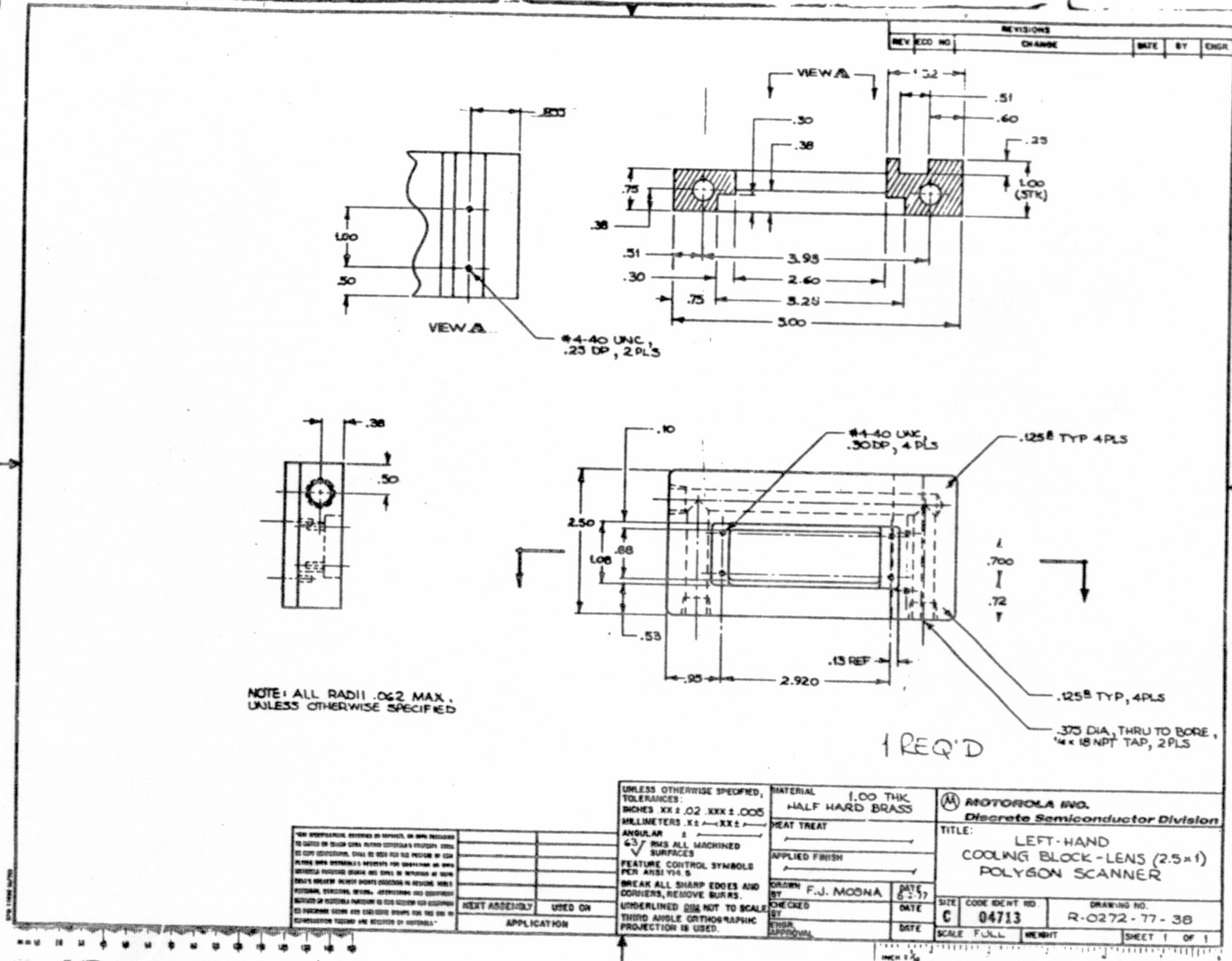
SCALE FULL

WEIGHT

SHEET 1 OF 1

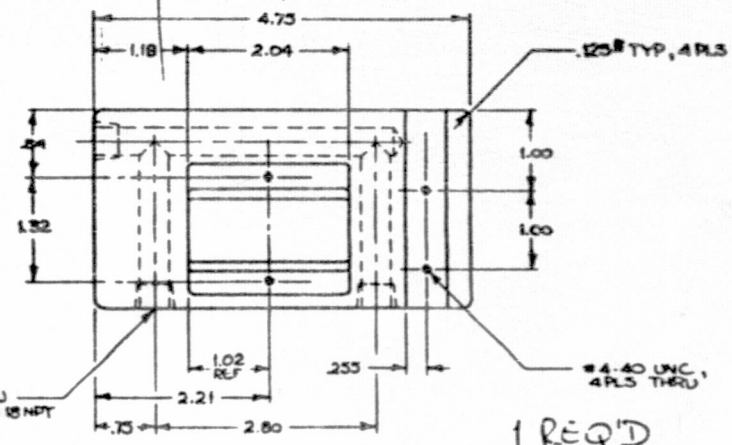
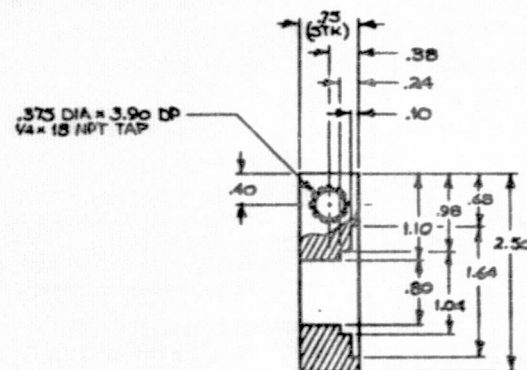
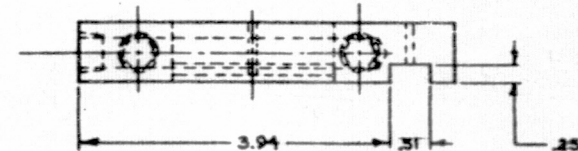


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REVISIONS					
REV	ECO NO	CHANGE	DATE	BY	ENGR

NOTE: ALL RADI .012 MAX
UNLESS OTHERWISE SPECIFIED

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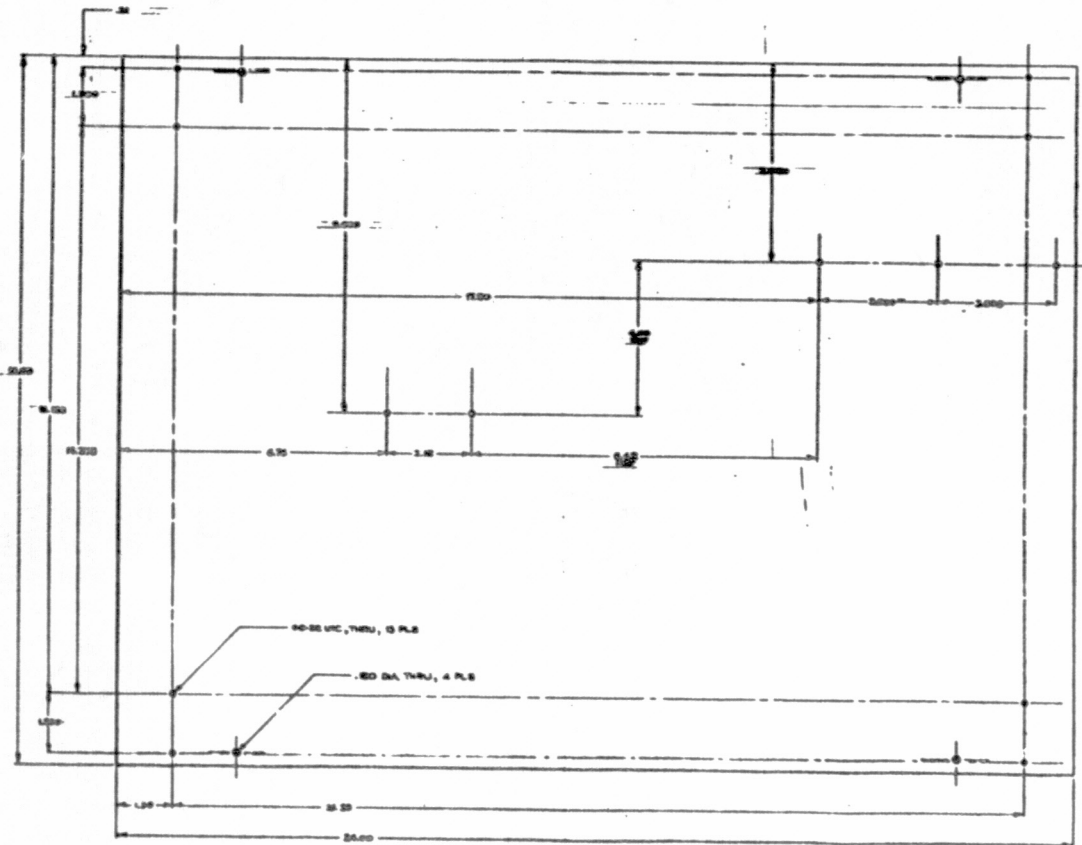
NEXT ASSEMBLY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
DIMES X1 ± .02 XXX ± .005
DIMETERS X1 ± .02 X2 ± .01
ANGLES ± 2
63 ✓ DIMS ALL MACHINED
SURFACES
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5
BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.
UNDELINEK DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED.

MATERIAL		.75 THK HALF HARD BRASS
HEAT TREAT		
APPLIED FINISH		
DESIGNED BY	F. J. MOSNA	DATE
CHECKED BY		DATE
FOR		DATE

 MOTOROLA INC. Discrete Semiconductor Division			
TITLE: LEFT-HAND COOLING BLOCK - LENS (2.0x1) POLYGON SCANNER			
SIZE	CODE IDENT. NO	DRAWING NO	
C	04713	R-0272-77-39	
SCALE	FULL	WEIGHT	SHEET 1 OF 1

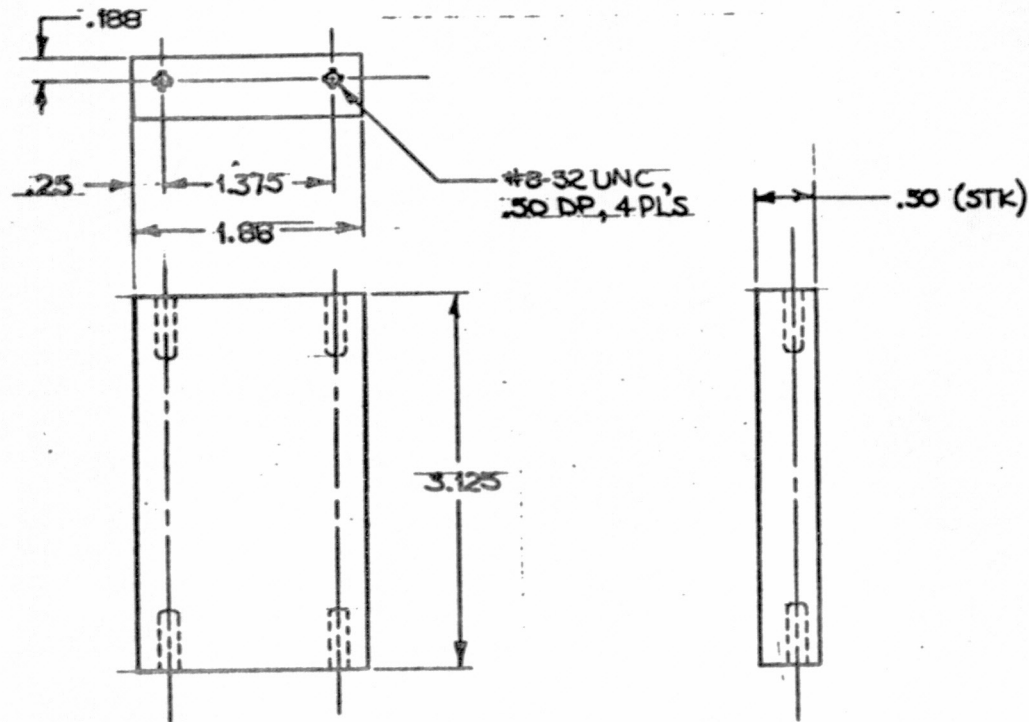
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1 REQ'D

REVISIONS 1. REVISED TO MEET REQUIREMENTS OF 8-04733-1 2. REVISED TO MEET REQUIREMENTS OF 8-04733-2 3. REVISED TO MEET REQUIREMENTS OF 8-04733-3 4. REVISED TO MEET REQUIREMENTS OF 8-04733-4 5. REVISED TO MEET REQUIREMENTS OF 8-04733-5 6. REVISED TO MEET REQUIREMENTS OF 8-04733-6 7. REVISED TO MEET REQUIREMENTS OF 8-04733-7 8. REVISED TO MEET REQUIREMENTS OF 8-04733-8 9. REVISED TO MEET REQUIREMENTS OF 8-04733-9 10. REVISED TO MEET REQUIREMENTS OF 8-04733-10		APPROVALS DESIGNED BY: J. A. MADONIA CHECKED BY: J. A. MADONIA APPROVED BY: J. A. MADONIA DATE: 10-1-77 SCALE: 1:1 SHEET: 1 OF 1	
DESCRIPTION LEFT-HAND SCANNER MOUNTING PLATE PART NO: 8-04733 REV: 1 DATE: 10-1-77 DESIGNED BY: J. A. MADONIA CHECKED BY: J. A. MADONIA APPROVED BY: J. A. MADONIA SCALE: 1:1 SHEET: 1 OF 1		QUANTITY 1 REQ'D	

REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY ENGR.



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NEXT ASSEMBLY	USED ON

APPLICATION

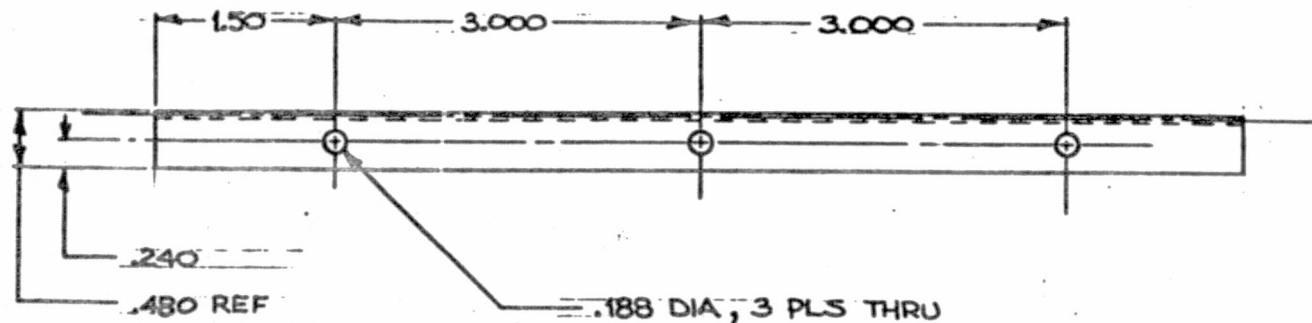
UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02 .XXX ± .005
MILLIMETERS .X ± .1 .XX ± .01
ANGULAR ±
125 RMS ALL MACHINED SURFACES.
FEATURE CONTROL SYMBOLS PER ANSI Y14.5.
BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE.
THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

MATERIAL	.30 THK 6061-T6 AL
HEAT TREAT	
APPLIED FINISH	
DRAWN BY	F.J. MOSNA
CHECKED BY	
ENGR. APPROVAL	
DATE	7-22-77
DATE	
DATE	

MOTOROLA INC. Discrete Semiconductor Division	
TITLE: SUPPORT BLOCK, LEFT-HAND SCANNER	
SIZE B	CODE IDENT. NO. 04713
SCALE FULL	WEIGHT
DRAWING NO. R-0245-77-207	SHEET 1 OF 1



REVISIONS					
REV.	ECO NO.	CHANGE	DATE	BY	ENGR.



DRILL HOLES AS SHOWN IN GEAR RACK SUPPLIED (9")

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ANY SPECIFICATIONS, DRAWINGS OR DATA FURNISHED
BY MOTOROLA SHALL REMAIN MOTOROLA'S PROPERTY, SAME
TO BE KEPT CONFIDENTIAL, SHALL BE USED FOR THE PURPOSE OF COM-
PLYING WITH MOTOROLA'S REQUESTS FOR QUOTATION OR REPLY
TO MOTOROLA PURCHASE ORDERS AND SHALL BE RETURNED AT MOTOR-
OLA'S REQUEST. PATENT RIGHTS ENDORSED IN DESIGNS, TOOLS,
APPARATUS, DRAWINGS, DEVICES, INFORMATION AND EQUIPMENT
SUPPLIED BY MOTOROLA PURSUANT TO THIS REQUEST FOR QUOTATION
OR PURCHASE ORDER AND EXCLUSIVE RIGHTS FOR THE USE IN
REPRODUCTION THEREOF ARE RESERVED BY MOTOROLA.

NEXT ASSEMBLY USED ON
APPLICATION

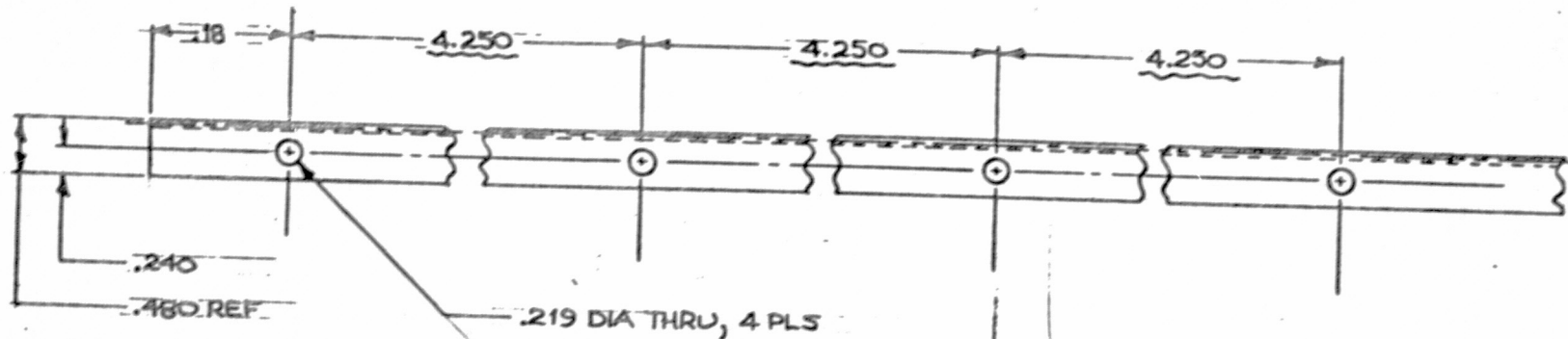
UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02 .XXX ± .005
MILLIMETERS .X ± .XX ±
ANGULAR ±
✓ RMS ALL MACHINED
SURFACES.
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5.
BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED.

MATERIAL
SUPPLIED
HEAT TREAT
APPLIED FINISH
DRAWN BY F.J. MOSNA DATE 7-22-77
CHECKED BY DATE
ENGR. APPROVAL DATE

MOTOROLA INC.
Discrete Semiconductor Division
TITLE:
RACK GEAR HOLE PATTERN,
LEFT-HAND SCANNER
SIZE B CODE IDENT. NO. 04713 DRAWING NO. R-0245-77-202
SCALE FULL WEIGHT SHEET 1 OF 1



REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY



DRILL HOLES AS SHOWN IN RACK GEAR SUPPLIED (18")

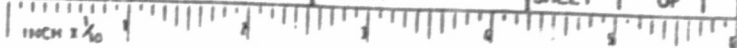
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NEXT ASSEMBLY USED ON
APPLICATION

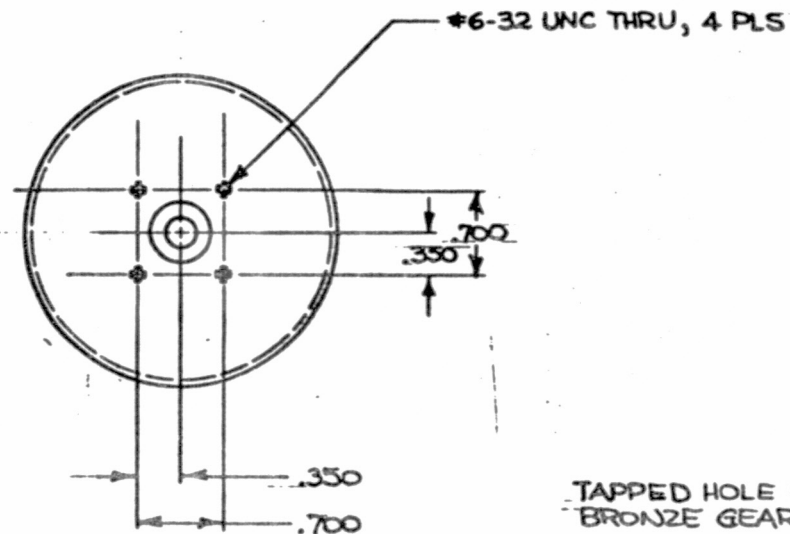
UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02 .XXX ± .005
MILLIMETERS .X ± .1 .XX ± .1
ANGULAR ±
✓ RMS ALL MACHINED SURFACES.
FEATURE CONTROL SYMBOLS PER ANSI Y14.5.
BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

MATERIAL
SUPPLIED
HEAT TREAT
APPLIED FINISH
DRAWN BY F.J. MOSNA DATE 7-22-77
CHECKED BY DATE
ENGR. APPROVAL DATE

MOTOROLA INC.
Discrete Semiconductor Division
TITLE:
RACK GEAR HOLE PATTERN,
LEFT-HAND SCANNER
SIZE B CODE IDENT. NO. 04713 DRAWING NO. R-0245-77-201
SCALE FULL WEIGHT SHEET 1 OF 1



REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY ENGR.



TAPPED HOLE PATTERN FOR
BRONZE GEAR (SUPPLIED)

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NEXT ASSEMBLY USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02 .XXX ± .005
MILLIMETERS .X ± .XX ±
ANGULAR ±
✓ RMS ALL MACHINED SURFACES.
FEATURE CONTROL SYMBOLS PER ANSI Y14.5.
BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE.
THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

MATERIAL
SUPPLIED

HEAT TREAT

APPLIED FINISH

DRAWN BY F.J. MOSNA

CHECKED BY

ENGR. APPROVAL

DATE 7-22-77

DATE

DATE

MOTOROLA INC.
Discrete Semiconductor Division

TITLE:

GEAR HOLE PATTERN,
LEFT-HAND SCANNER

SIZE

B

CODE IDENT. NO.

04713

DRAWING NO.

R-0245-77-205

SCALE FULL

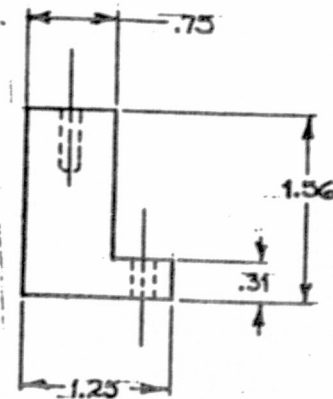
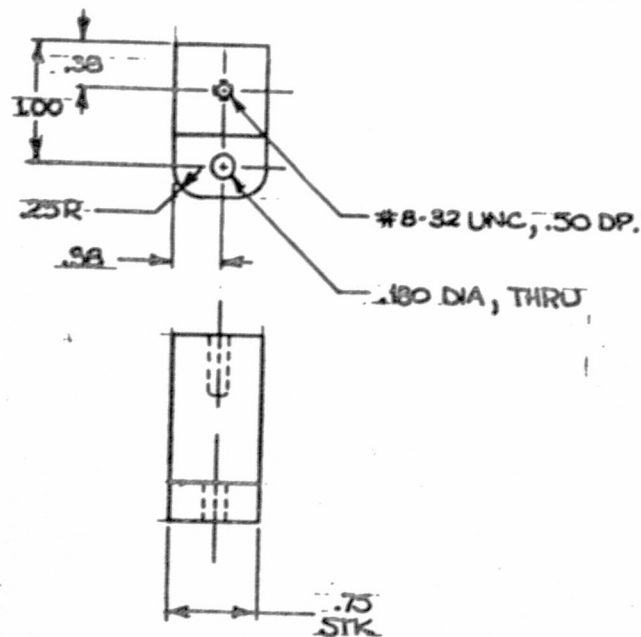
WEIGHT

SHEET 1 OF 1

INCH 1/16

INCH 1/16

REVISIONS					
REV.	ECO NO.	CHANGE	DATE	BY	ENGR.



4 REQ'D

UNLESS OTHERWISE SPECIFIED,
TOLERANCES:

INCHES .XX ± .02 .XXX ± .005

MILLIMETERS .X ± .1 .XX ± .05

ANGULAR ±

125 RMS ALL MACHINED
SURFACES.

FEATURE CONTROL SYMBOLS
PER ANSI Y14.5.

BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.

UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED.

MATERIAL .75 THK
6061-T6 AL

HEAT TREAT

APPLIED FINISH

DRAWN BY F.J. MOSNA

DATE 7-22-76

CHECKED BY

DATE

ENGR. APPROVAL

DATE



MOTOROLA INC.

Discrete Semiconductor Division

TITLE:

PLATE PEDESTAL,
LEFT-HAND SCANNER

SIZE CODE IDENT. NO.

B 04713

DRAWING NO.

R-0245-77-206

SCALE FULL WEIGHT

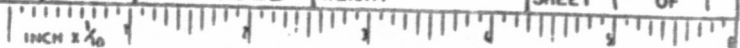
SHEET 1 OF 1

NEXT ASSEMBLY

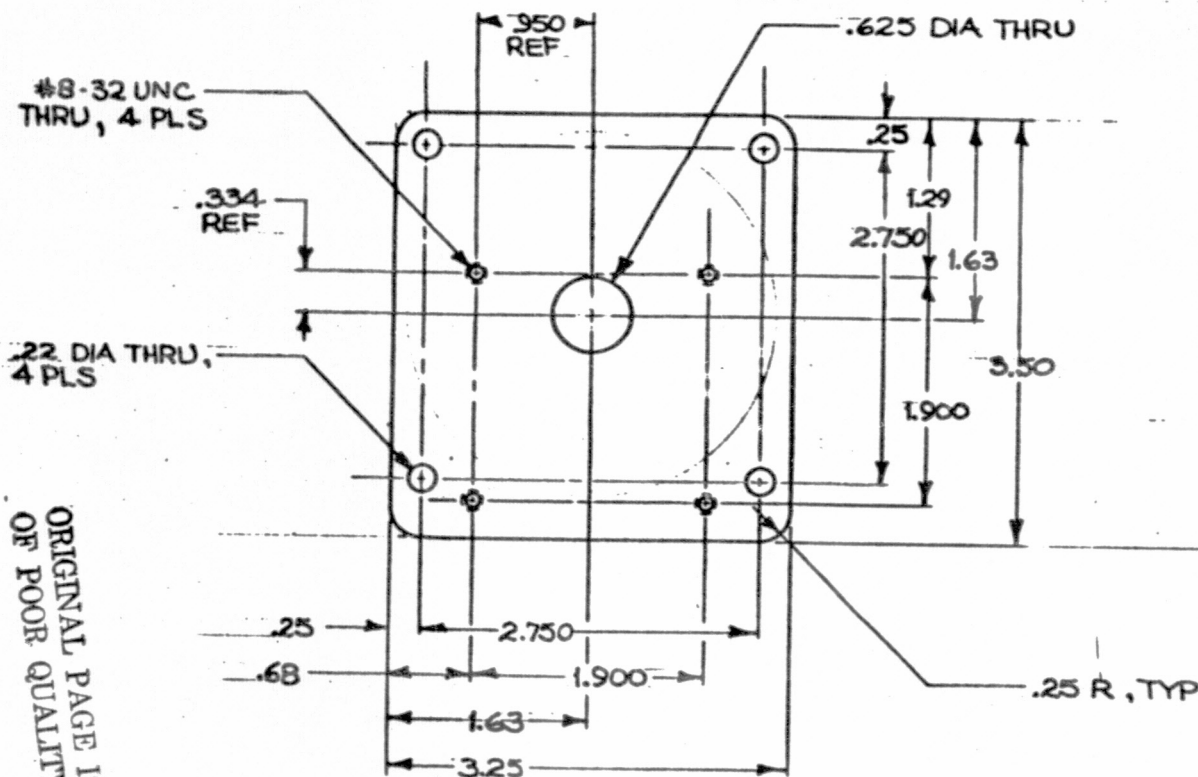
USED ON

APPLICATION

"ANY SPECIFICATIONS, DRAWINGS OR REPORTS, OR DATA FURNISHED TO ORDER OR SELLER SHALL REMAIN MOTOROLA'S PROPERTY. SHALL BE KEPT CONFIDENTIAL. SHALL BE USED FOR THE PURPOSE OF COMPLYING WITH MOTOROLA'S REQUESTS FOR QUOTATION OR WITH MOTOROLA'S PURCHASE ORDERS AND SHALL BE RETURNED AT MOTOROLA'S REQUEST. PATENT RIGHTS INVENTED IN DESIGN, TOOLS, PATTERNS, DRAWINGS, DEVICES, INFORMATION AND EQUIPMENT SUPPLIED BY MOTOROLA PURSUANT TO THIS REQUEST FOR QUOTATION OR PURCHASE ORDER AND EXCLUSIVE RIGHTS FOR THE USE OR REPRODUCTION THEREOF ARE RESERVED BY MOTOROLA."



REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY ENGR.



2 REQ'D

"ANY SPECIFICATIONS, DRAWINGS OR REPORTS, OR DATA FURNISHED TO BUYER OR SELLER SHALL REMAIN MOTOROLA'S PROPERTY, SHALL BE KEPT CONFIDENTIAL, SHALL BE USED FOR THE PURPOSE OF COMPLYING WITH MOTOROLA'S REQUESTS FOR QUOTATION OR WITH MOTOROLA PURCHASE ORDERS AND SHALL BE RETURNED AT MOTOROLA'S REQUEST. PATENT RIGHTS (INCLUDING IN DESIGNS, TOOLS, PATTERNS, DRAWINGS, DEVICES, INFORMATION AND EQUIPMENT) SUPPLIED BY MOTOROLA PURSUANT TO THIS REQUEST FOR QUOTATION OR PURCHASE ORDER AND EXCLUSIVE RIGHTS FOR THE USE IN REPRODUCTION THEREOF ARE RESERVED BY MOTOROLA."

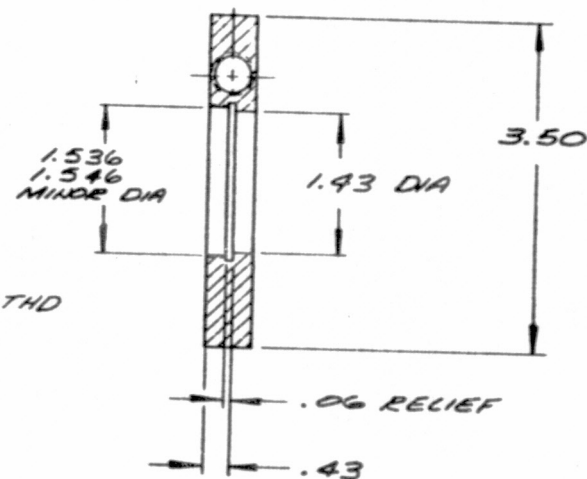
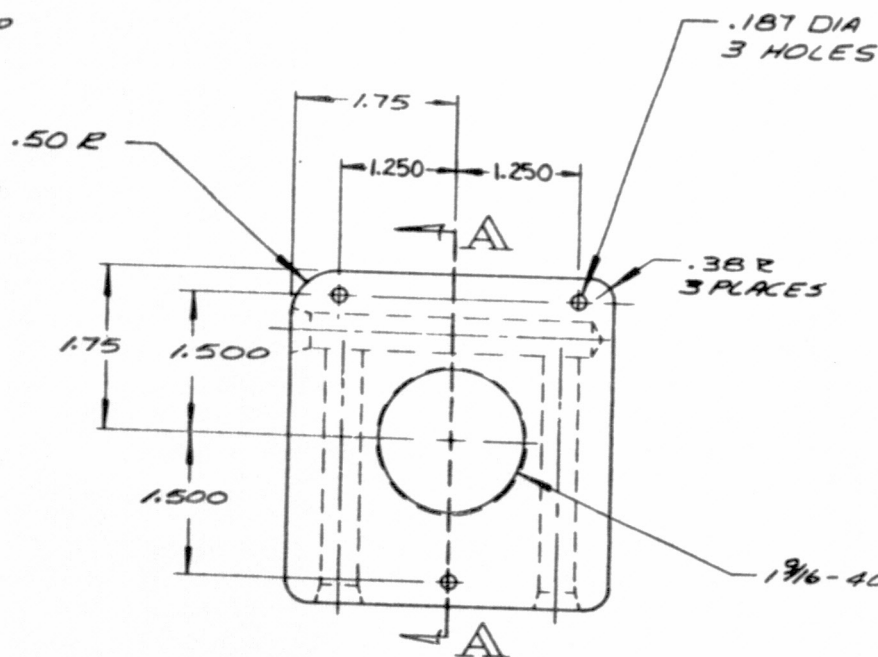
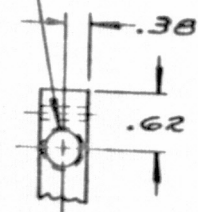
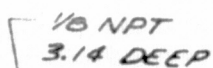
NEXT ASSEMBLY USED ON
APPLICATION

UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02 .XXX ± .005
MILLIMETERS .XX ± .XX ±
ANGULAR ±
125 ✓ RMS ALL MACHINED SURFACES.
FEATURE CONTROL SYMBOLS PER ANSI Y14.5.
BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

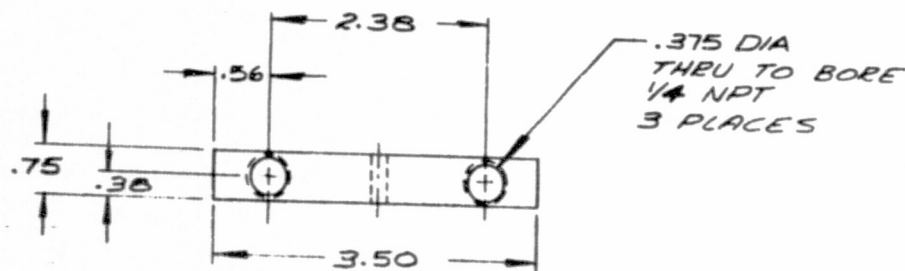
MATERIAL .125 THK
6061-T6 AL
HEAT TREAT
APPLIED FINISH
DRAWN BY F.J. MOSNA DATE 7-19-77
CHECKED BY DATE
ENGR. APPROVAL DATE

MOTOROLA INC.
Discrete Semiconductor Division
TITLE:
MOTOR ADAPTER PLATE
SIZE CODE IDENT. NO. DRAWING NO.
B 04713 R-0245-77-203
SCALE FULL WEIGHT SHEET / OF /





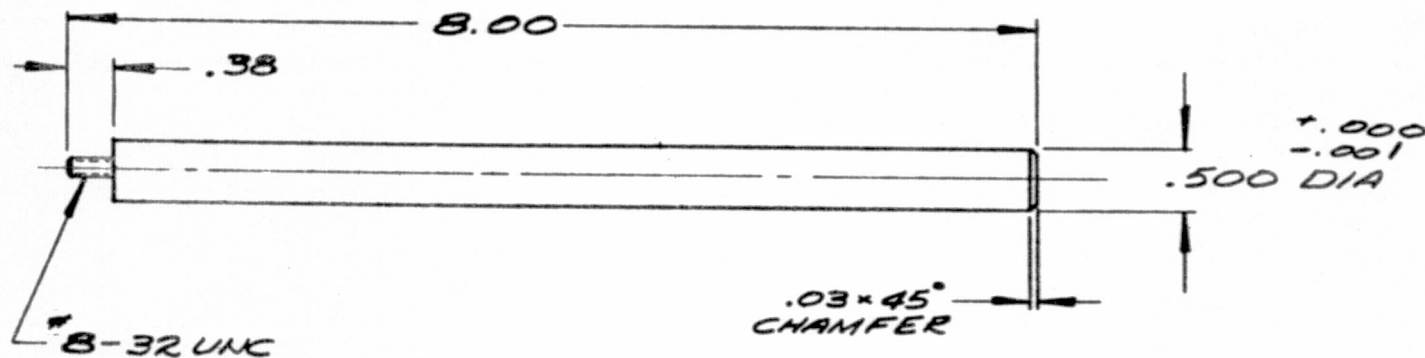
SECTION A-A



REVISIONS					
REV.	ECO NO.	CHANGE	DATE	BY	ENGR.

THIS SPECIFICATION, DRAWINGS OR DETAILS, OR DATA FURNISHED BY MOTOROLA OR ITS DIVISIONS, SHALL BE USED FOR THE PURPOSES OF THE PURCHASE ORDER ONLY. NO OTHER RIGHTS OR OBLIGATIONS SHALL BE INCURRED BY THE PURCHASER OR THE SUPPLIER BY THE USE OF THIS SPECIFICATION, DRAWINGS OR DETAILS, OR DATA FURNISHED BY MOTOROLA OR ITS DIVISIONS. THE PURCHASER SHALL BE RESPONSIBLE FOR THE PROTECTION OF THE RIGHTS OF MOTOROLA AND ITS DIVISIONS. THE PURCHASER SHALL BE RESPONSIBLE FOR THE PROTECTION OF THE RIGHTS OF MOTOROLA AND ITS DIVISIONS. THE PURCHASER SHALL BE RESPONSIBLE FOR THE PROTECTION OF THE RIGHTS OF MOTOROLA AND ITS DIVISIONS.		UNLESS OTHERWISE SPECIFIED, TOLERANCES: INCHES XX ± .0005 OR .0005 MILLIMETERS XX ± .005 ANGULAR ± 1/2° SURFACES 63 RMS ALL MACHINED FEATURE CONTROL SYMBOLS PER ANSI Y14.5 BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS UNDERLINED DIM NOT TO SCALE THIRD ANGLE ORTHOGRAPHIC PROJECTION		MATERIAL HALF HARD BRASS		(M) MOTOROLA INC. Discrete Semiconductor Division	
				HEAT TREAT T		TITLE: COOLING BLOCK FOR BEAM SPIL	
NEXT ASSEMBLY USED ON		APPLICATION		APPLIED FINISH T		DATE JUL 1971	
				DRAWN BY G. BUDAY		CHECKED BY R. G. R.	
				SIZE C		CODE IDENT NO 04713	
				DATE		D.P. OR I.D. NO P-0872-77-27	

REVISIONS					
REV.	ECO NO.	CHANGE	DATE	BY	ENGR.



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"ANY SPECIFICATIONS, DRAWINGS OR REPRINTS, OR DATA FURNISHED TO BIDDER OR SELLER SHALL REMAIN MOTOROLA'S PROPERTY, SHALL BE KEPT CONFIDENTIAL, SHALL BE USED FOR THE PURPOSE OF COMPLYING WITH MOTOROLA'S REQUESTS FOR QUOTATION OR WITH MOTOROLA PURCHASE ORDERS AND SHALL BE RETURNED AT MOTOROLA'S REQUEST. PATENT RIGHTS (SHOWN IN DESIGNS, TOOLS, PATTERNS, DRAWINGS, DEVICES, INFORMATION AND EQUIPMENT SUPPLIED BY MOTOROLA PURSUANT TO THIS REQUEST FOR QUOTATION OR PURCHASE ORDER AND EXCLUSIVE RIGHTS FOR THE USE OR REPRODUCTION THEREOF ARE RESERVED BY MOTOROLA."

NEXT ASSEMBLY

USED ON

APPLICATION

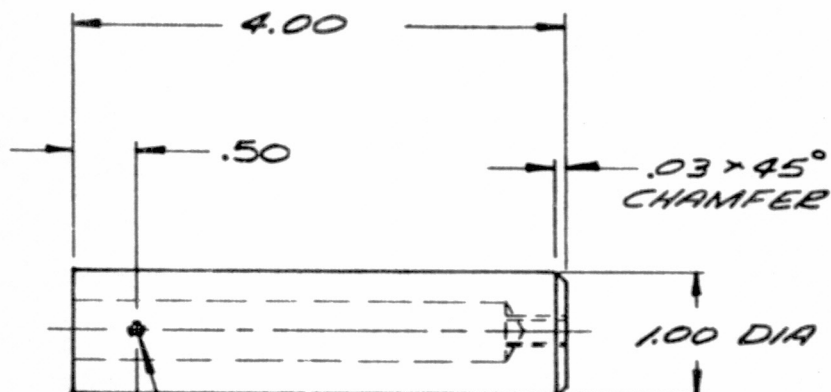
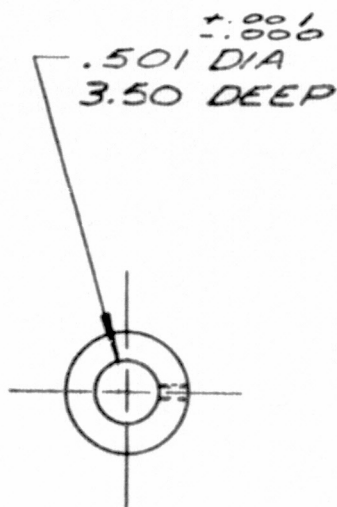
UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02 .XXX ± .005
MILLIMETERS .X ± H .XX ± H
ANGULAR ± H
63 RMS ALL MACHINED
✓ SURFACES.
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5.
BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED.

MATERIAL
C.R.S.
HEAT TREAT
APPLIED FINISH
DRAWN BY G. BUDAY DATE 7-12-77
CHECKED BY DATE
ENGR. APPROVAL DATE

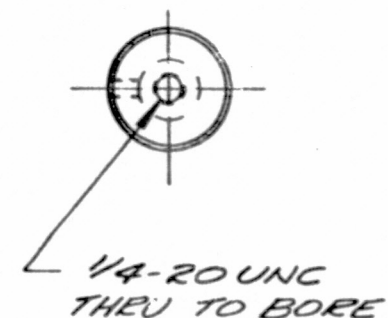
MOTOROLA INC.
Discrete Semiconductor Division
TITLE:
SHAFT
SIZE B CODE IDENT. NO. 04713 DRAWING NO. E-0272-77-28
SCALE FULL WEIGHT SHEET 1 OF 1



REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY ENGR.



#6-32 UNK
THRU TO BORE



UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02 XXX ± .005
MILLIMETERS .X ± H .XX ± H
ANGULAR ± H
63 RMS ALL MACHINED
SURFACES.
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5.
BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED.

MATERIAL 6061-T6
ALUM
HEAT TREAT
APPLIED FINISH
DRAWN BY G. BUDAY DATE 7-12-77
CHECKED BY DATE
ENGR. APPROVAL DATE

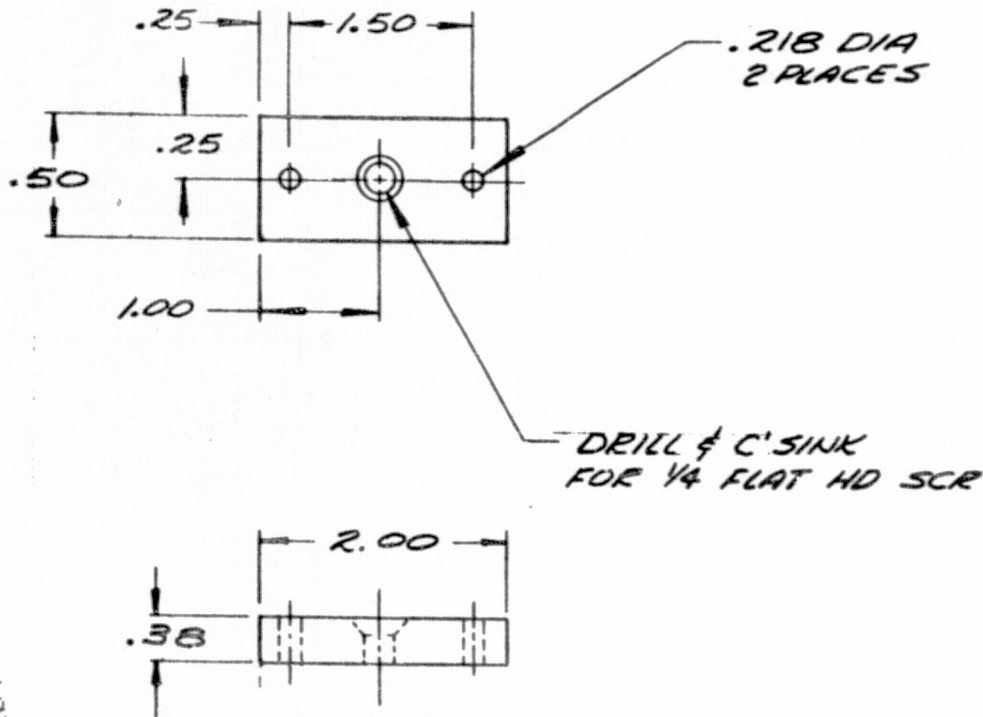
MOTOROLA INC.
Discrete Semiconductor Division
TITLE: POST
SIZE B CODE IDENT. NO. 04713 DRAWING NO. E-0272-77-29
SCALE FULL WEIGHT SHEET 1 OF 1

ANY SPECIFICATIONS, DRAWINGS OR REPRINTS, OR DATA FURNISHED TO BIDDER OR SELLER SHALL REMAIN MOTOROLA'S PROPERTY, SHALL BE KEPT CONFIDENTIAL, SHALL BE USED FOR THE PURPOSE OF COMPLYING WITH MOTOROLA'S REQUESTS FOR QUOTATION OR WITH MOTOROLA PURCHASE ORDERS AND SHALL BE RETURNED AT MOTOROLA'S REQUEST. PATENT RIGHTS EMBODIED IN DESIGNS, TOOLS, PATTERNS, DRAWINGS, DEVICES, INFORMATION AND EQUIPMENT SUPPLIED BY MOTOROLA PURSUANT TO THIS REQUEST FOR QUOTATION OR PURCHASE ORDER AND EXCLUSIVE RIGHTS FOR THE USE IN REPRODUCTION THEREOF ARE RESERVED BY MOTOROLA.

NEXT ASSEMBLY USED ON
APPLICATION



REVISIONS					
REV.	ECO NO.	CHANGE	DATE	BY	ENGR.



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OF POOR QUALITY

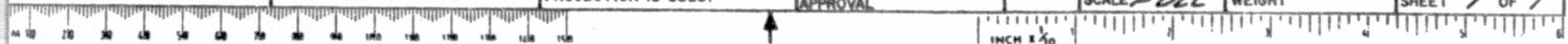
UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02 XXX ± .005
MILLIMETERS .X ± .1 H .XX ± .1
ANGULAR ± 1°
✓ RIMS ALL MACHINED
SURFACES.
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5.
BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED.

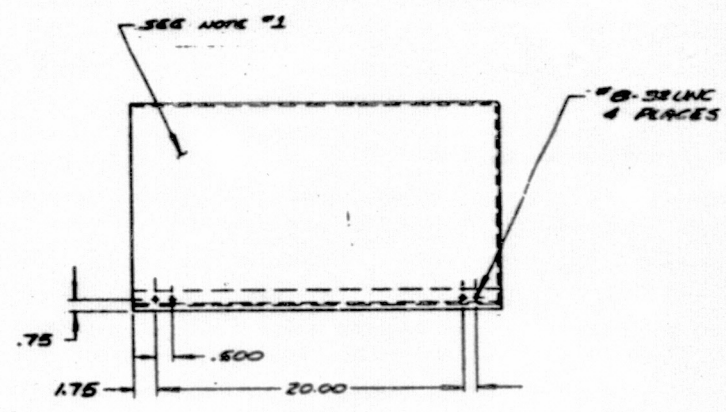
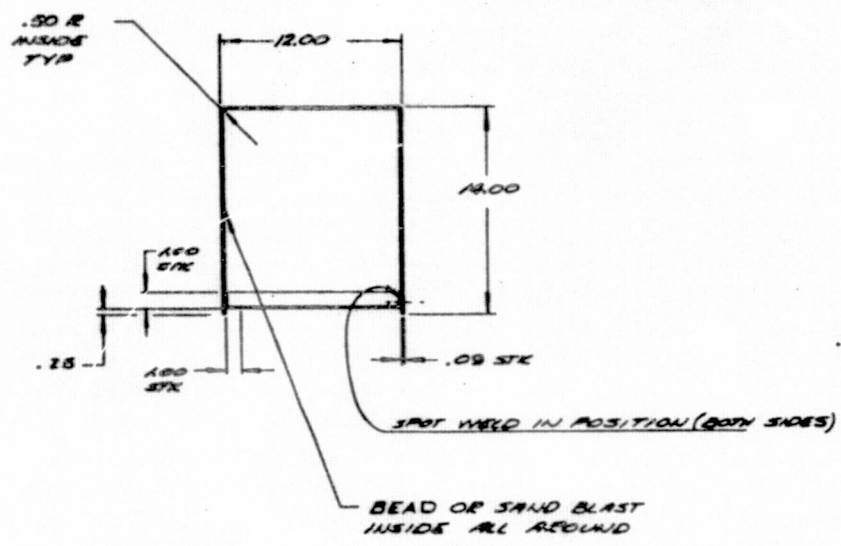
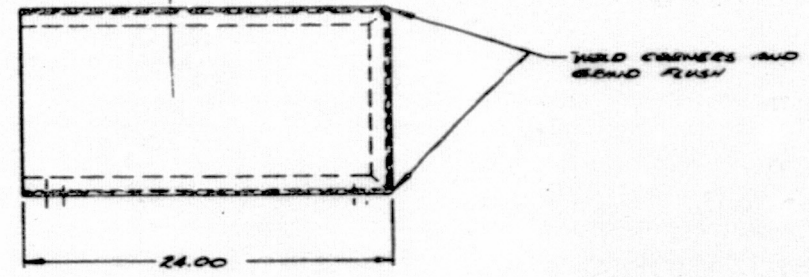
MATERIAL 6061-T6
ALUM
HEAT TREAT
APPLIED FINISH
DRAWN BY G. BUDAY DATE 7-12-77
CHECKED BY DATE
ENGR. APPROVAL DATE

MOTOROLA INC.
Discrete Semiconductor Division
TITLE: BASE
SIZE B CODE IDENT. NO. 04713 DRAWING NO. E-0272-77-30
SCALE FULL WEIGHT SHEET 1 OF 1

NEXT ASSEMBLY USED ON
APPLICATION

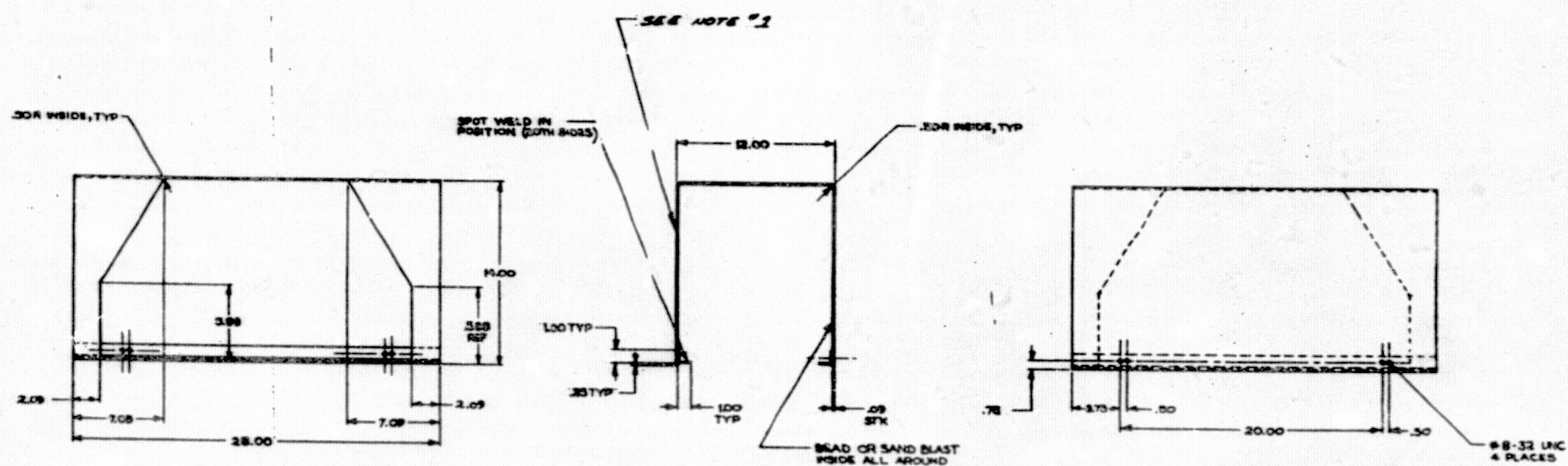
ALL SPECIFICATIONS, DRAWINGS OR REPRINTS, OR DATA FURNISHED
BY BIDDER OR SELLER SHALL REMAIN MOTOROLA'S PROPERTY. SHALL
BE KEPT CONFIDENTIAL, SHALL BE USED FOR THE PURPOSE OF CON-
FORMING WITH MOTOROLA'S REQUESTS FOR ROTATION OR WITH
MOTOROLA PURCHASE ORDERS AND SHALL BE RETURNED AT MOTO-
ROLA'S REQUEST. PATENT RIGHTS (INCLUDING IN DESIGNS, TOOLS,
TECHNICAL DRAWINGS, DEVICES, INFORMATION AND EQUIPMENT)
APPLIED BY MOTOROLA PURSUANT TO THIS REQUEST FOR QUOTATION
PURCHASE ORDER AND EXCLUSIVE RIGHTS FOR THE USE IN
PRODUCTION THEREOF ARE RESERVED BY MOTOROLA.





1 - DECREASE, REPAIRS, BUFF SAND.
PAINT ANTHRAZOLE BLUE.
(OUTSIDE SURFACES ONLY)

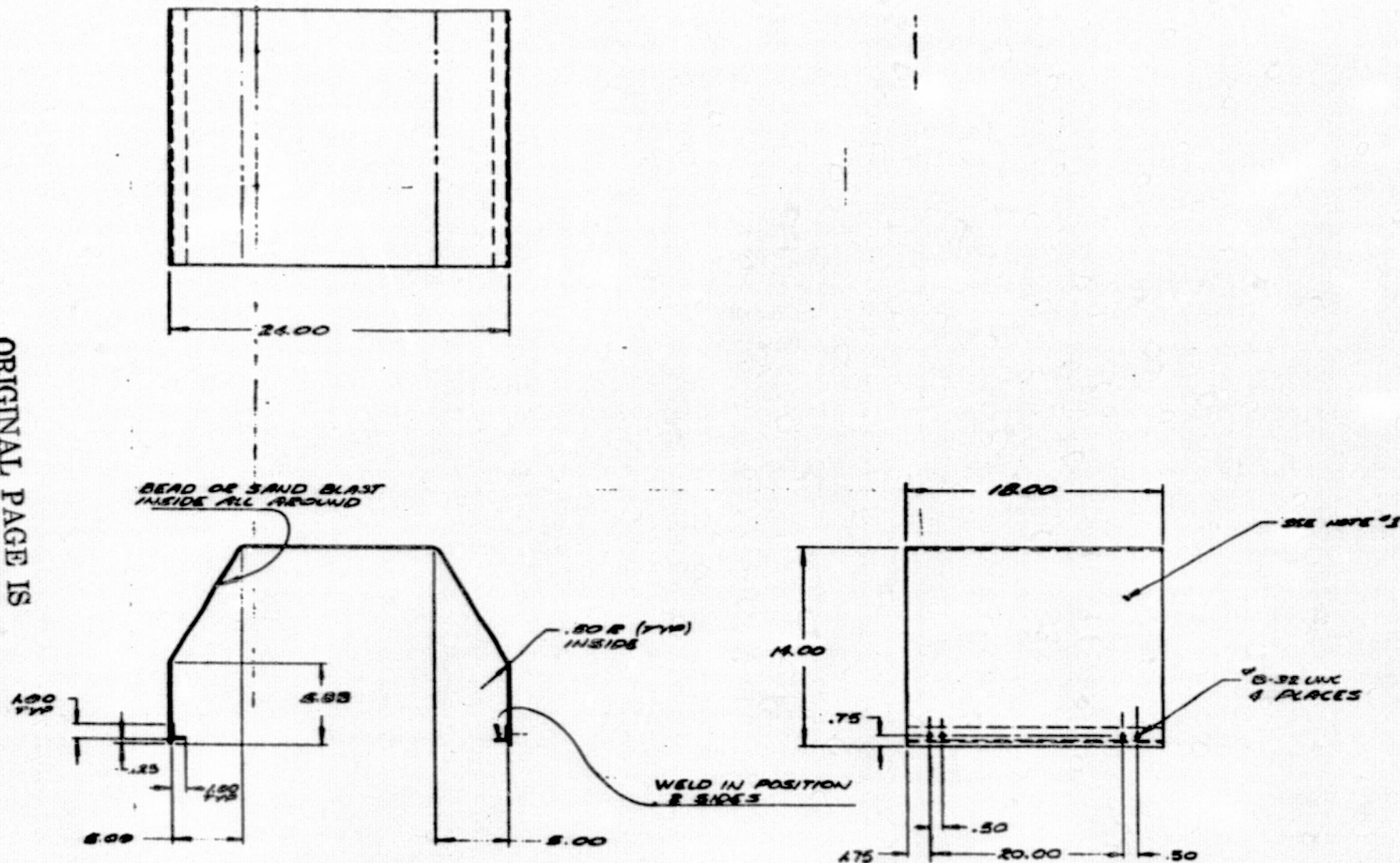
UNLESS OTHERWISE SPECIFIED, TOLERANCES: DIMENSIONS IN INCHES: .0005 DIMENSIONS IN MILLIMETERS: .01 ANGULAR: .1° SURFACES: .0005 FEATURE CONTROL SYMBOLS: PER ASME Y14.5 UNLESS ALL DIMENSIONS ARE SPECIFIED, REWORK SURFACES SHALL BE TO THE BEST OF THE MANUFACTURER'S ABILITY. DIMENSIONS DO NOT SCALE. THIS DRAWING IS THE PROPERTY OF MOTOROLA AND IS NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.		MATERIAL: 5052H ALLOY HEAT TREAT: T3 FINISH: POLISHED DRAWN BY: J. BUDAY CHECKED BY: J. BUDAY DATE: 10/1/77 SCALE: 1/4" = 1"	MOTOROLA AND Semiconductor Division TITLE: COVER-BEAM TABLE REAR SECTION, LEFT SIDE (120" x 24.0") SHEET: 1 OF 1 DATE: 10/1/77 SCALE: 1/4" = 1"
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5. DEBRASS, PRIME, BUFF & SAND.
PAINT ANTI-CORROSION BLUE
(OUTSIDE SURFACE ONLY)

LESS OTHERWISE SPECIFIED FINISHES INCHES .03 XXX .035 MILLIMETERS .81 XXX .81 ANGULAR 8 ALL ALL MACHINED FEATURE CONTROL SYMBOLS PER ASME Y14.5 REMOVE ALL SHARP EDGES AND NOTCHES, REMOVE BURRS. UNLESS OTHERWISE SPECIFIED UNLESS OTHERWISE SPECIFIED PROJECTION IS USED		MATERIAL 5052 H-32 AL ALLOY HEAT TREAT APPLIED FINISH DRIVER F.J. MOSNA DATE BY SCALE SIZE WEIGHT	APPROVED BY Engineer/Inspector Division TITLE COVER-BEAM TABLE CENTER SECTION (14.0x28.0) SIZE 8 64713 SCALE 1/4 WEIGHT 1 OF 1
---	--	---	---

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1- DESIGNEE, PRIME, BUREAU & SUB.
PAINT MOTOROLA BLUE
(OUTSIDE SURFACE ONLY)

UNLESS OTHERWISE SPECIFIED, TOLERANCES: FRACTIONS .XX XX XX .005 DECIMALS .XX XX XX .005 DIMENSIONS .XX XX XX .005 HORIZONTAL .XX XX XX .005 VERTICAL .XX XX XX .005 FEATURE CONTROL SYMBOLS FOR ASH 174 2. WEAR ALL SHARP EDGES AND CORNERS, REMOVE BURRS UNLESS OTHERWISE NOTED TO SCALE THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED		MATERIAL 5052H-32 AL ALLOY HEAT TREAT APPLIED FINISH DATE BY CHECKED DATE BY APPROVED DATE	MOTOROLA DIV. Corporate Semiconductor Division TITLE COVER BEAM TABLE CENTER SECTION (180 x 24.0) DRAWING NO. 84713 E-0278-77-24 SCALE 1/4" = 1" WEIGHT SHEET OF
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[illegible]

[illegible]

Technical drawing of a mechanical part, showing a side view and a cross-sectional view.

Side View Dimensions:

- Overall length: 7.00
- Central section length: .50
- Feature length: .56

Cross-sectional View Dimensions:

- Top feature diameter: .70 DIA.
- Central hole diameter: 2.50 DIA.
- Inner hole diameter: 1.00
- Inner hole offset: .50
- Outer hole offset: 1.00
- Outer hole diameter: 1.00
- Outer hole offset: .75
- Outer hole diameter: 1.00

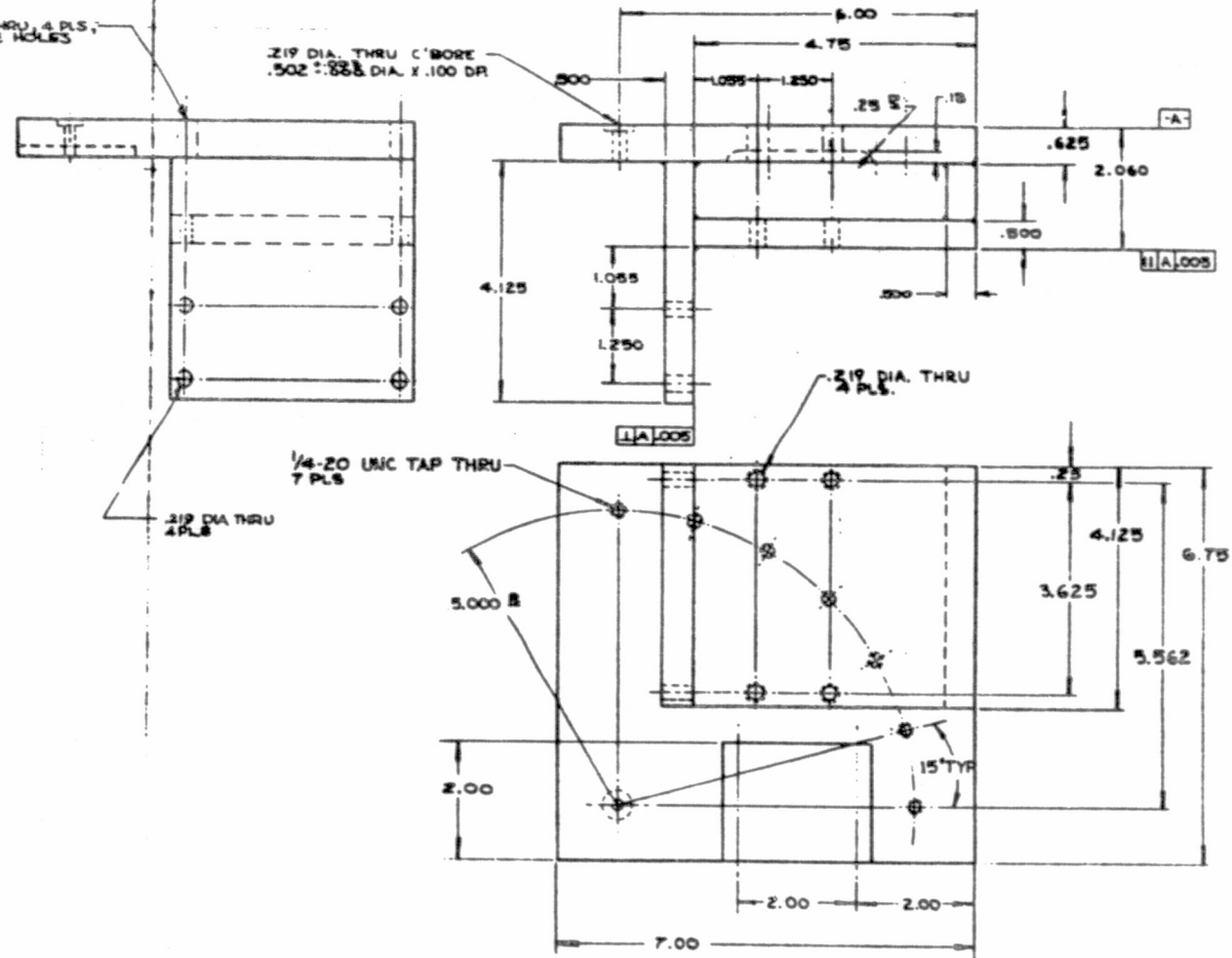
Notes and Tolerances:

- .4965 DIA. $+.0000$ / $-.0005$ SLIP FIT FOR I.D. OF BEARING
- .04 X 45° CHAMF.
- 8-36 UNF TAP THRU
- 10-32 UNC 2 PLACES

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OF POOR QUALITY

— 2 —

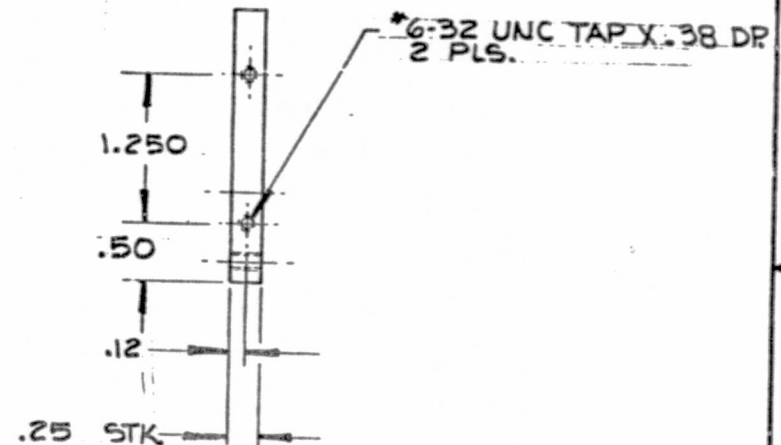
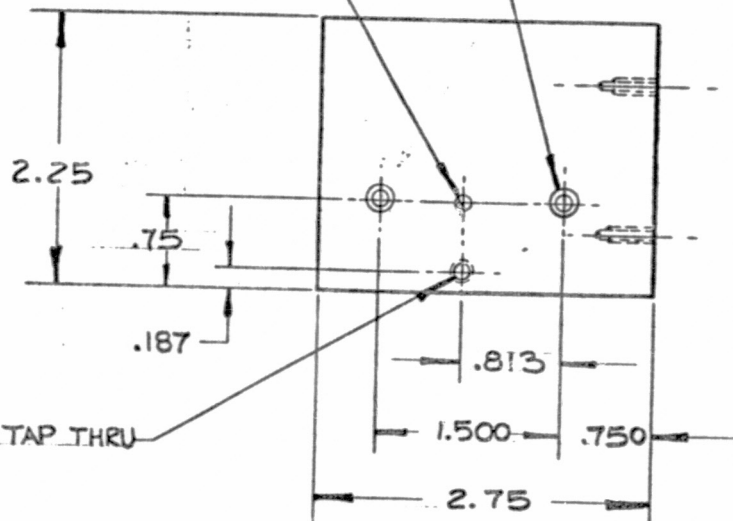
319 DIA. THRU
4 PLS.

[illegible]

REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY ENGR.

.1255 $\pm .0003$
-.0000 DIA THRU
PRESS FIT FOR 1/8 DOWEL

.152 DIA THRU C'BORE
.242 DIA. X .140 DP.
2 PLS.



*6-32 UNC TAP X .38 DP
2 PLS.

*10-32 UNF TAP THRU

UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02 .XXX ± .005
MILLIMETERS .X ± .1 .XX ± .01
ANGULAR ± 1°
✓ 1257 RMS ALL MACHINED
SURFACES.
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5.
BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED.

MATERIAL
6061-T6 AL.

HEAT TREAT

APPLIED FINISH

DRAWN
BY RICK K.

DATE
8-16-77

CHECKED
BY

DATE

ENGR.
APPROVAL

DATE



MOTOROLA INC.

Discrete Semiconductor Division

TITLE:

MOUNTING BASE PLATE

NEXT ASSEMBLY USED ON

APPLICATION

SIZE CODE IDENT. NO.

B 04713

DRAWING NO.

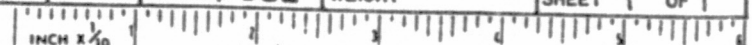
R-0296-77-13

SCALE FULL

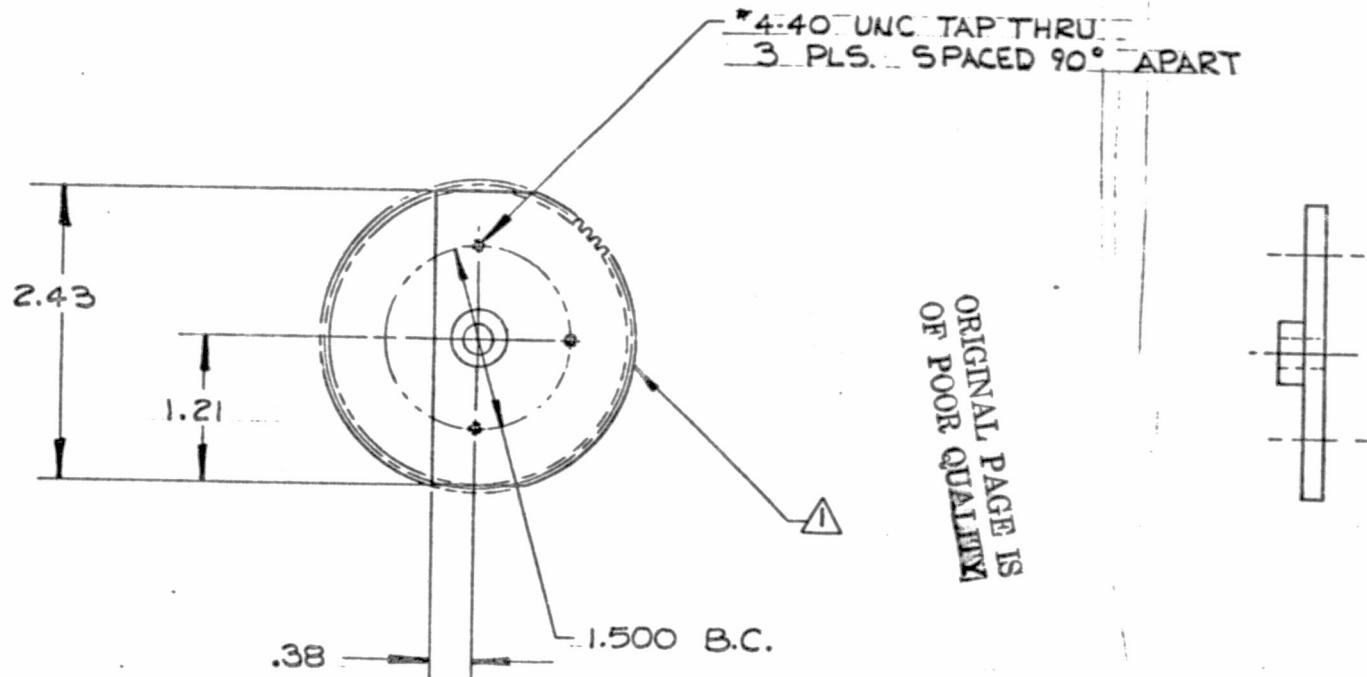
WEIGHT

SHEET 1 OF 1

"ANY SPECIFICATIONS, DRAWINGS OR REPRINTS, OR DATA FURNISHED TO BIDDER OR SELLER SHALL REMAIN MOTOROLA'S PROPERTY. SHALL BE KEPT CONFIDENTIAL, SHALL BE USED FOR THE PURPOSE OF COMPLYING WITH MOTOROLA'S REQUESTS FOR QUOTATION OR WITH MOTOROLA PURCHASE ORDERS AND SHALL BE RETURNED AT MOTOROLA'S REQUEST. PATENT RIGHTS EMBODIED IN DESIGNS, TOOLS, PATTERNS, DRAWINGS, DEVICES, INFORMATION AND EQUIPMENT SUPPLIED BY MOTOROLA PURSUANT TO THIS REQUEST FOR QUOTATION OR PURCHASE ORDER AND EXCLUSIVE RIGHTS FOR THE USE IN REPRODUCTION THEREOF ARE RESERVED BY MOTOROLA."



REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY
				ENGR.



⚠ PART SHOWN IS BERG WORM GEAR #W48B29-S120

NOTE:

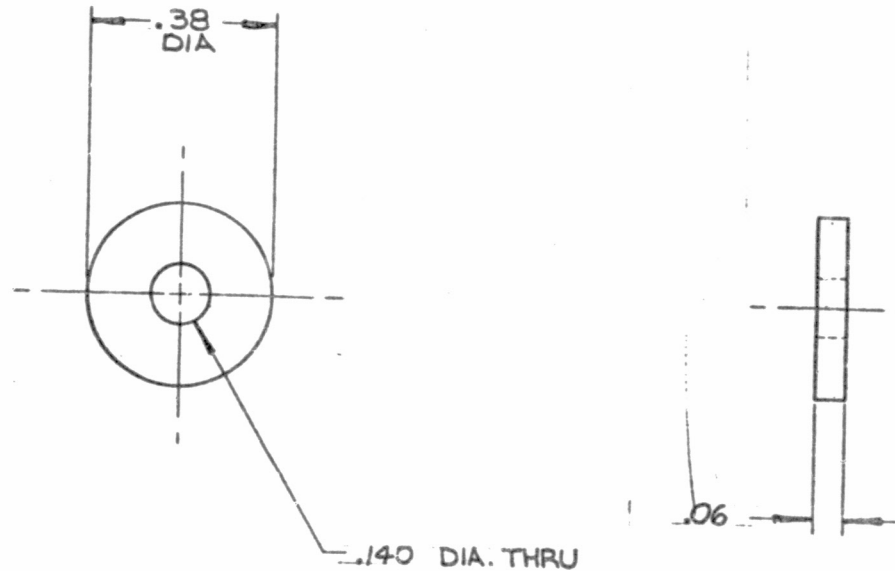
"ANY SPECIFICATIONS, DRAWINGS OR REPRINTS, OR DATA FURNISHED TO BIDDER OR SELLER SHALL REMAIN MOTOROLA'S PROPERTY. SHALL BE KEPT CONFIDENTIAL. SHALL BE USED FOR THE PURPOSE OF COMPLYING WITH MOTOROLA'S REQUESTS FOR QUOTATION OR WITH MOTOROLA PURCHASE ORDERS AND SHALL BE RETURNED AT MOTOROLA'S REQUEST. PATENT RIGHTS EMBODIED IN DESIGNS, TOOLS, PATTERNS, DRAWINGS, DEVICES, INFORMATION AND EQUIPMENT SUPPLIED BY MOTOROLA PURSUANT TO THIS REQUEST FOR QUOTATION OR PURCHASE ORDER AND EXCLUSIVE RIGHTS FOR THE USE IN REPRODUCTION THEREOF ARE RESERVED BY MOTOROLA."

UNLESS OTHERWISE SPECIFIED, TOLERANCES: INCHES .XX ± .02 .XXX ± .005 MILLIMETERS .X ± .1 .XX ± .1 ANGULAR ± 1° 12.5 RMS ALL MACHINED SURFACES. FEATURE CONTROL SYMBOLS PER ANSI Y14.5. BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS. UNDERLINED DIM NOT TO SCALE. THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.		MATERIAL SEE NOTE 1		HEAT TREAT		MOTOROLA INC. Discrete Semiconductor Division	
APPLIED FINISH		DRAWN BY RICK K.		DATE		TITLE: MODIFIED WORM GEAR	
NEXT ASSEMBLY		USED ON		CHECKED BY		DATE	
APPLICATION		ENGR. APPROVAL		DATE		DRAWING NO. R-0296-77-11	
SCALE FULL		WEIGHT		SHEET 1 OF 1			



INCH 1/16

REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY ENGR.



ANY SPECIFICATIONS, DRAWINGS OR REPRINTS OR DATA FURNISHED TO BIDDER OR SELLER SHALL REMAIN MOTOROLA'S PROPERTY. SHALL BE KEPT CONFIDENTIAL. SHALL BE USED FOR THE PURPOSE OF COMPLYING WITH MOTOROLA'S REQUESTS FOR QUOTATION OR WITH MOTOROLA PURCHASE ORDERS AND SHALL BE RETURNED AT MOTOROLA'S REQUEST. PATENT RIGHTS EMBODIED IN DESIGN, TOOLS, PATTERNS, DRAWINGS, DEVICES, INFORMATION AND EQUIPMENT SUPPLIED BY MOTOROLA PURSUANT TO THIS REQUEST FOR QUOTATION OR PURCHASE ORDER AND EXCLUSIVE RIGHTS FOR THE USE IN REPRODUCTION THEREOF ARE RESERVED BY MOTOROLA.

NEXT ASSEMBLY USED ON APPLICATION

UNLESS OTHERWISE SPECIFIED, TOLERANCES:
 INCHES .XX ± .02 .XXX ± .005
 MILLIMETERS .X ± .XX ± .1
 ANGULAR ± /-
 125 RMS ALL MACHINED SURFACES.
 FEATURE CONTROL SYMBOLS PER ANSI Y14.5.
 BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.
 UNDERLINED DIM NOT TO SCALE.
 THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

MATERIAL
 TEFLON

HEAT TREAT

APPLIED FINISH

DRAWN BY
 RICK K.

DATE
 9-17-77

CHECKED BY

DATE

ENGR. APPROVAL

DATE

MOTOROLA INC.
 Discrete Semiconductor Division

TITLE:

WASHER

SIZE
 B

CODE IDENT. NO.
 04713

DRAWING NO.

R-0296-77-5

SCALE 4X

WEIGHT

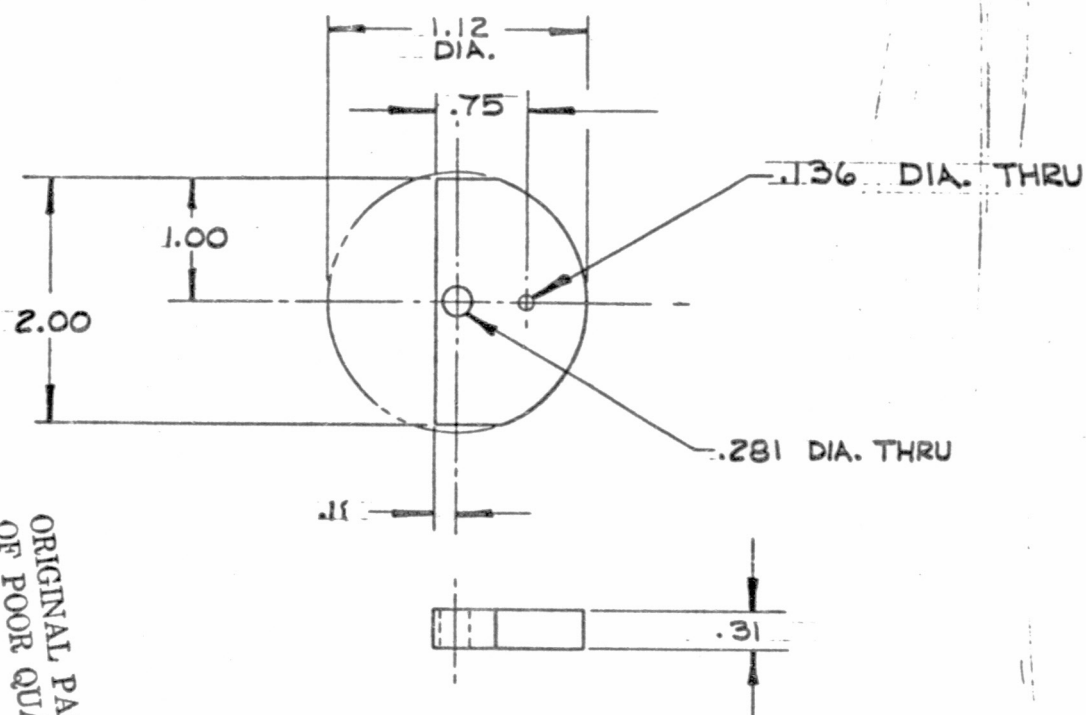
SHEET

OF



C-2

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OF POOR QUALITY



REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY

"ANY SPECIFICATIONS, DRAWINGS OR REPRINTS, OR DATA FURNISHED TO BIDDER OR SELLER SHALL REMAIN MOTOROLA'S PROPERTY. SHALL BE KEPT CONFIDENTIAL. SHALL BE USED FOR THE PURPOSE OF COMPLYING WITH MOTOROLA'S REQUESTS FOR QUOTATION OR WITH MOTOROLA'S REQUEST. PATENT RIGHTS EMBODIED IN DESIGNS, TOOLS, PATTERNS, DRAWINGS, DEVICES, INFORMATION AND EQUIPMENT SUPPLIED BY MOTOROLA PURSUANT TO THIS REQUEST FOR QUOTATION OR PURCHASE ORDER AND EXCLUSIVE RIGHTS FOR THE USE IN REPRODUCTION THEREOF ARE RESERVED BY MOTOROLA."

NEXT ASSEMBLY USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02 .XXX ± .005
MILLIMETERS .XX ± .XX ±
ANGULAR ±
125 ✓ RMS ALL MACHINED SURFACES.
FEATURE CONTROL SYMBOLS PER ANSI Y14.5.
BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE.
THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

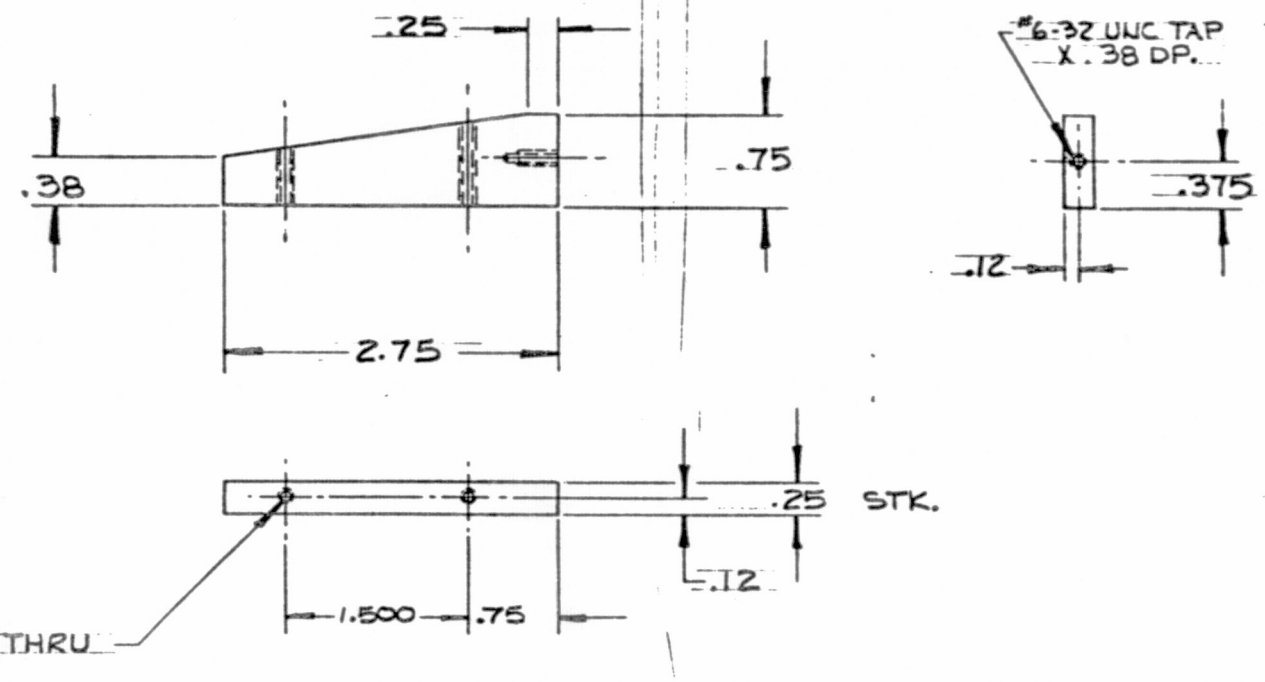
MATERIAL
P.V.C.
HEAT TREAT
APPLIED FINISH
DRAWN BY RICK K. DATE 9-17-77
CHECKED BY DATE
ENGR. APPROVAL DATE

MOTOROLA INC.
Discrete Semiconductor Division
TITLE:
SPACER
SIZE B CODE IDENT. NO. 04713 DRAWING NO. R-0296-77-12
SCALE FULL WEIGHT SHEET 1 OF 1

SPD 11631 (6/76)



REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY

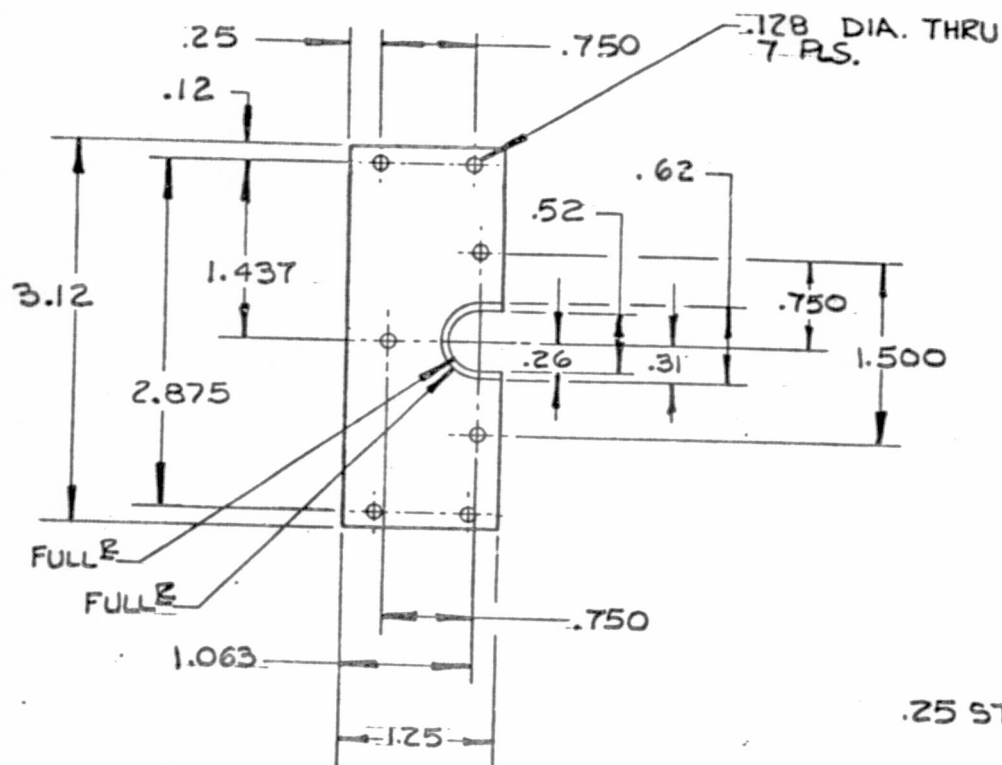


ORIGINAL PAGE IS
OF POOR QUALITY

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UNLESS OTHERWISE SPECIFIED, TOLERANCES: INCHES .XX ± .02 .XXX ± .005 MILLIMETERS .X ± .1 .XX ± .1 ANGULAR ± 1° ✓ RMS ALL MACHINED SURFACES. FEATURE CONTROL SYMBOLS PER ANSI Y14.5. BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS. UNDERLINED DIM NOT TO SCALE. THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.		MATERIAL		MOTOROLA INC. Discrete Semiconductor Division	
		6061-T6 AL.			
		HEAT TREAT		TITLE:	
		APPLIED FINISH			
NEXT ASSEMBLY		DRAWN BY		DATE	
USED ON		CHECKED BY		DATE	
APPLICATION		ENGR. APPROVAL		DATE	
		SIZE		CODE IDENT. NO.	
		B		04713	
		DRAWING NO.		R-0296-77-14	
		SCALE FULL		WEIGHT	
		SHEET		OF 1	





REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY ENGR.

UNLESS OTHERWISE SPECIFIED;
TOLERANCES:
INCHES .XX±.02 .XXX±.005
MILLIMETERS .XX±.1 .XXX±.05
ANGULAR ±
12.5 RMS ALL MACHINED SURFACES.
FEATURE CONTROL SYMBOLS PER ANSI Y14.5.
BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE.
THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

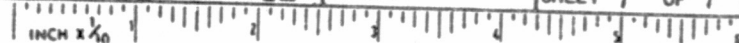
MATERIAL
6061-T6 AL.
HEAT TREAT
APPLIED FINISH
DRAWN BY RICK K. DATE 9-19-77
CHECKED BY DATE
ENGR. APPROVAL DATE

MOTOROLA INC.
Discrete Semiconductor Division
TITLE:
WORM GEAR MOUNTING PLATE
SIZE B CODE IDENT. NO. 04713 DRAWING NO. R-0296-77-9
SCALE FULL WEIGHT SHEET 1 OF 1

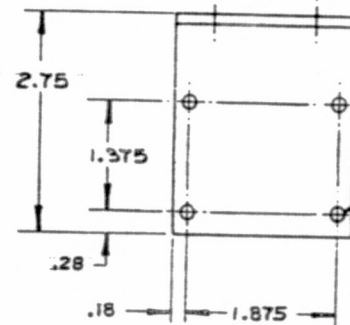
"XX" SPECIFICATIONS, DRAWINGS OR REPRINTS, OR DATA FURNISHED TO BIDDER OR SELLER SHALL REMAIN MOTOROLA'S PROPERTY. SHALL BE KEPT CONFIDENTIAL, SHALL BE USED FOR THE PURPOSE OF COMPLYING WITH MOTOROLA'S REQUESTS FOR QUOTATION OR WITH MOTOROLA PURCHASE ORDERS AND SHALL BE RETURNED AT MOTOROLA'S REQUEST. PATENT RIGHTS EMBODIED IN DESIGNS, TOOLS, PATTERNS, DRAWINGS, DEVICES, INFORMATION AND EQUIPMENT SUPPLIED BY MOTOROLA PURSUANT TO THIS REQUEST FOR QUOTATION OR PURCHASE ORDER AND EXCLUSIVE RIGHTS FOR THE USE IN REPRODUCTION THEREOF ARE RESERVED BY MOTOROLA."

NEXT ASSEMBLY USED ON

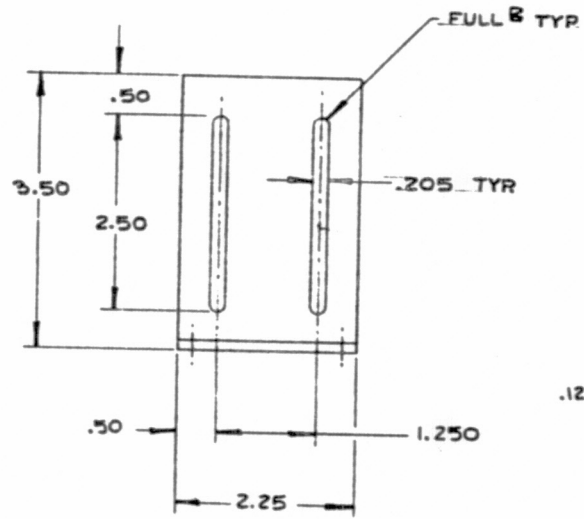
APPLICATION



REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY ENGR



.205 DIA. THRU
4 PLS.



FULL 8 TYP

.205 TYP

.12 R
MAX.

.12 STK.

ORIGINAL PAGE IS
OF POOR QUALITY

NOTE: DIMENSIONS IN PARENTS ARE IN INCHES. DIMENSIONS IN BRACKETS ARE IN MILLIMETERS. DIMENSIONS IN PARENTS ARE IN INCHES. DIMENSIONS IN BRACKETS ARE IN MILLIMETERS. DIMENSIONS IN PARENTS ARE IN INCHES. DIMENSIONS IN BRACKETS ARE IN MILLIMETERS.

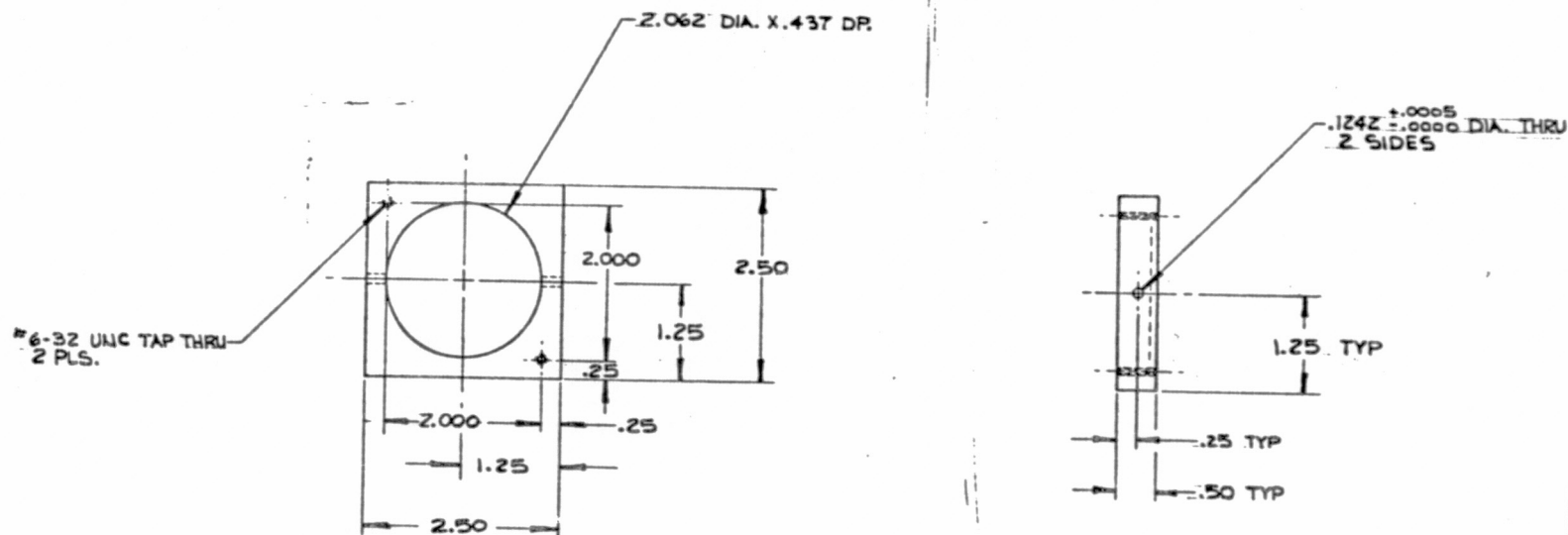
APPLICATION	USED ON
NEXT ASSEMBLY	

UNLESS OTHERWISE SPECIFIED,
TOLERANCES
INCHES XX 1.0Z XXX ± .005
MILLIMETERS .XX ± .XX ± .005
ANGULAR ±
12.5/ RMS ALL MACHINED
✓ SURFACES
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5
BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED.

MATERIAL
5052 H32 AL.
HEAT TREAT
APPLIED FINISH
DRAWN BY
RICK K.
DATE
9-18-77
CHECKED BY
DATE
APPROVAL
DATE

MOTOROLA INC. Discrete Semiconductor Division			
TITLE: MOUNTING BRACKET			
SIZE C	CODE IDENT. NO. 04713	DRAWING NO. R-0296-77-15	
SCALE FULL	WEIGHT	SHEET 1 OF 1	

REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY



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NEXT ASSEMBLY USED ON APPLICATION

UNLESS OTHERWISE SPECIFIED, TOLERANCES:
 INCHES .XX ± .02 .XXX ± .005
 MILLIMETERS .XX ± .XX ±
 ANGULAR ±
 12.5 RMS ALL MACHINED SURFACES
 FEATURE CONTROL SYMBOLS PER ANSI Y14.5
 BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.
 UNDERLINED DIM NOT TO SCALE
 THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

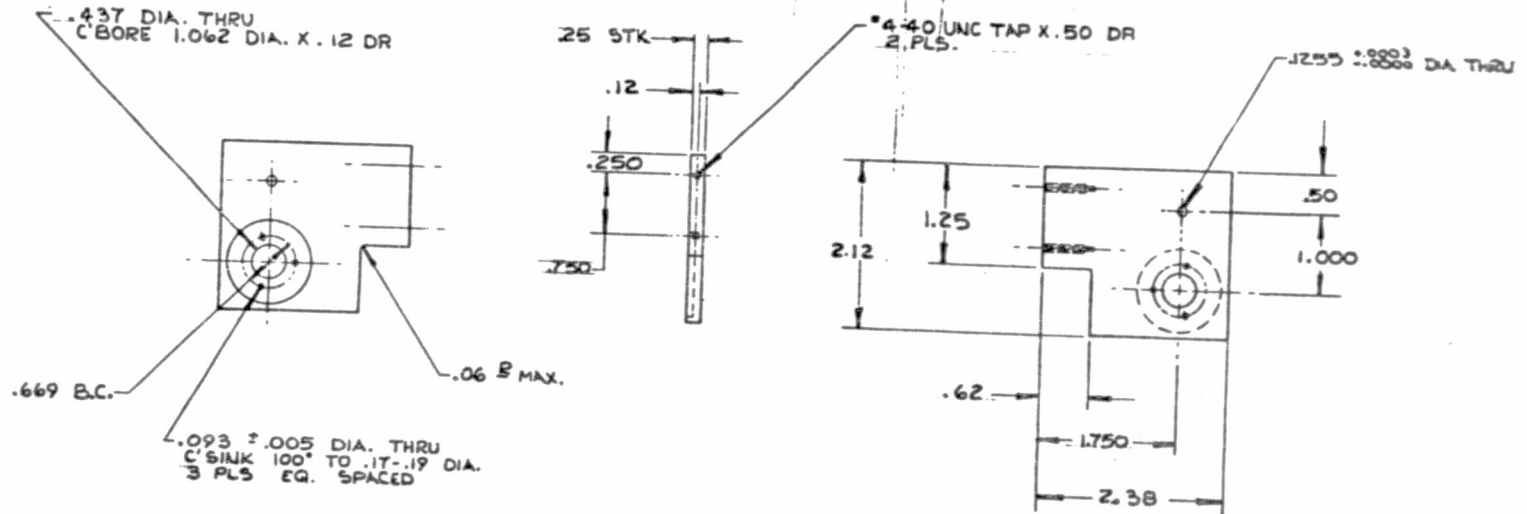
MATERIAL
 6061-T6 AL.
 HEAT TREAT
 APPLIED FINISH
 DRAWN BY
 RICK K.
 CHECKED BY
 DATE
 APPROVAL

MOTOROLA INC.
 Discrete Semiconductor Division
 TITLE:
 MIRROR HOLDER
 SIZE CODE IDENT. NO.
 C 04713
 DRAWING NO.
 R-0296-77-22
 SCALE FULL WEIGHT SHEET 1 OF 1

100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500 520 540 560 580 600 620 640 660 680 700 720 740 760 780 800 820 840 860 880 900 920 940 960 980 1000

INCH 1/16

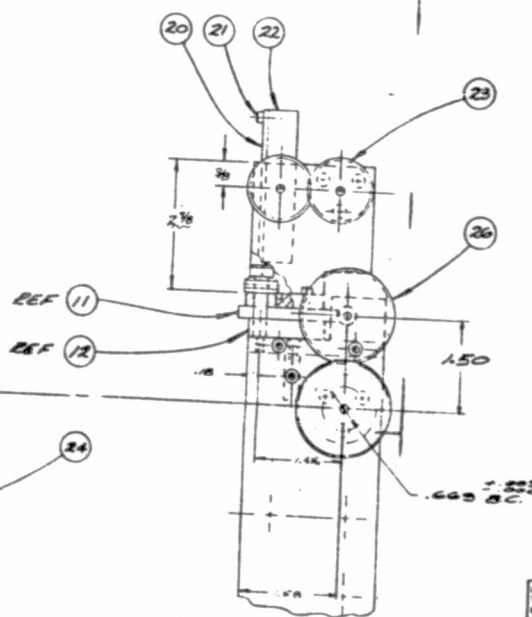
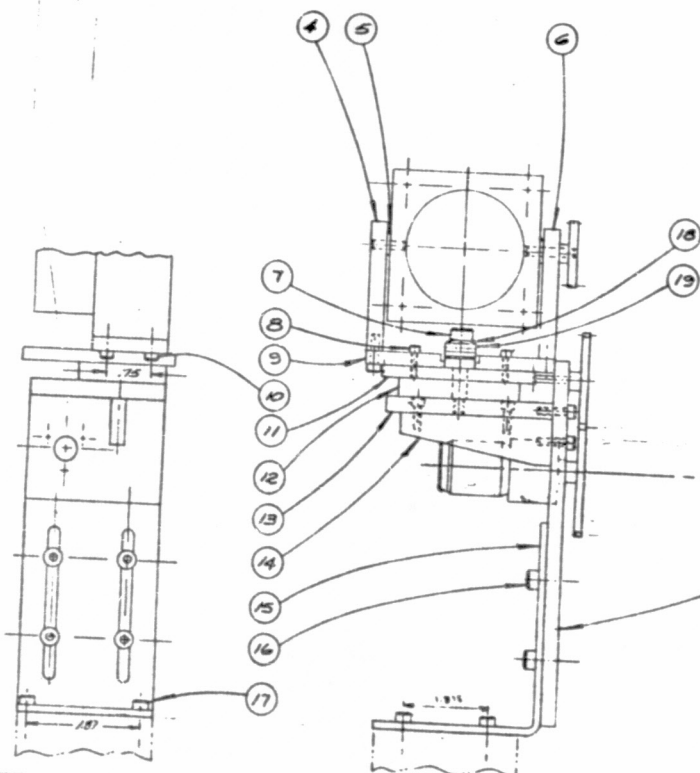
REVISIONS			
REV.	ECO NO.	CHANGE	DATE BY ENGR



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UNLESS OTHERWISE SPECIFIED, TOLERANCES: INCHES XX.XX ± .005 MILLIMETERS .XX ± .XX		MATERIAL 6061-T6 AL.		MOTOROLA INC. Discrete Semiconductor Division	
ANGULAR 1/2		HEAT TREAT		TITLE: MIRROR & MOTOR MOUNT	
RMS ALL MACHINED SURFACES		APPLIED FINISH		DRAWN BY RICK K.	
FEATURE CONTROL SYMBOLS PER ANSI Y14.5		DATE 2-19-77		DATE	
BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS		CHECKED BY		DATE	
UNDERLINED DIM NOT TO SCALE		ENGINEER		DATE	
THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.		APPROVAL		SCALE	
NEXT ASSEMBLY USED ON		WEIGHT		SHEET OF 1	
APPLICATION		WEIGHT		SHEET OF 1	

REVISIONS			
REV	ECO NO	ZONE	CHANGE
			DATE BY ENG



26	2	15 RD SPUR GEAR
25	6	M2x2MM FLAT HD SCR
24	1	1/4x2 1/4x6.0 LG ALUM
23	2	10 RD SPUR GEAR
21	4	1/2x2 1/2x2 1/2 ALUM
20	1	1/8x40 INCH 14 LG S.N.C.S
19	1	1/8x2 1/2x2 1/2 ALUM
18	1	1/4 1.0 TAPERED BEARING
17	4	1/8x32 INCH 14 LG S.N.C.S
16	4	1/8x24 INCH 14 LG S.N.C.S
15	1	1/8x2 1/4x3 ALUM SHEET
14	1	1/4x3 1/4x2 1/2 ALUM
13	1	1/4x2 1/4x2 3/4 ALUM
12	1	3/4x2 1/4 DIA MODDED PVC
11	1	250 RD NODD GEAR
10	7	1/4x32 INCH 6.6 LG "N.C.S
9	1	1/4x1 1/2x3 1/4 ALUM
8	3	1/4x40 INCH 3 1/2 LG S.N.C.S
7	1	1/4 DIAx100 SHOULDER SCREW
6	2	1/8x2 0x2 1/8 ALUM
5	2	1/2 DIAx.66 THICK PEXLON
4	1	1/4x2 1/4x2 1/8 ALUM
3	1	1/8 DIAx.66 LG
2	2	MICO DOWEL (25C) DRILL ROD
1	1	1/4 DIAx.100 LG DRILL ROD (1/4 INCH)
ITEM	QTY	DESCRIPTION

UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
NICH'S 30.3 AND 30.5 . . .
MILLIMETERS 30.3 AND 30.5
ANGULAR
✓ RMS ALL MACHINED
SURFACES
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5.
BREATHE ALL BREATHEDG AND
CORNERS, REMOVE BURRS
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED.

ITEM NO	
MATERIAL	
HEAT TREAT	
APPLIED FINISH	
DESIGNED BY <i>J. B. Blevins</i>	DATE
CHECKED BY	DATE
ENGR	

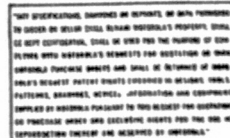
DESCRIPTION		
(M) MOTOROLA INC. Discrete Semiconductor Division		
TITLE:		
MIRROR ROTATIONAL AND PIVOTING ASS'Y		
SIZE	CODE IDENT NO.	DRAWING NO.
D	04713	E-0296-77

THEY SPECIFICALLY MENTIONED AN INDIVIDUAL WHO WAS MENTIONED
AS BEING IN THE AREA. OTHER INDIVIDUALS MENTIONED WERE
NOT SPECIFICALLY MENTIONED AS BEING IN THE AREA OF THE
PLANE. ONE INDIVIDUAL MENTIONED WAS A LUTHERAN AND WAS
MENTIONED THAT HE WAS IN THE AREA OF THE PLANE. HE
WAS NOT SPECIFICALLY MENTIONED AS BEING IN THE AREA.
MENTIONED THAT HE WAS IN THE AREA OF THE PLANE.
MENTIONED THAT HE WAS IN THE AREA OF THE PLANE.
MENTIONED THAT HE WAS IN THE AREA OF THE PLANE.
MENTIONED THAT HE WAS IN THE AREA OF THE PLANE.
MENTIONED THAT HE WAS IN THE AREA OF THE PLANE.

HEAT ASSEMBLY	USED ON
APPLICATION	
	11/11/11

Technical drawing of a rectangular plate with a grid of holes. The plate is 3.00 units wide and 5.50 units high. There are 6 holes arranged in a 3x2 grid. The holes are .20 DIA THRU 6 PLS. The spacing between holes is 1.50 units. The distance from the left edge to the first hole is .50 units. The distance from the bottom edge to the first hole is .12 units. A detail view shows a cross-section of the plate with a thickness of .25 (STK).

 MOTOROLA INC. Discrete Semiconductor Division			
TITLE:			
MIRROR MOUNT - BOTTOM PLATE			
SIZE	CODE IDENT. NO.	DRAWING NO.	
C	04713	R-0297-77-7	
SCALE	FULL	WEIGHT	SHEET 1 OF 1



UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02 .XXX ± .005
MILLIMETERS .X ± .XX ± .1
ANGULAR 2
125 RMS ALL MACHINED
SURFACES
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5
BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED.

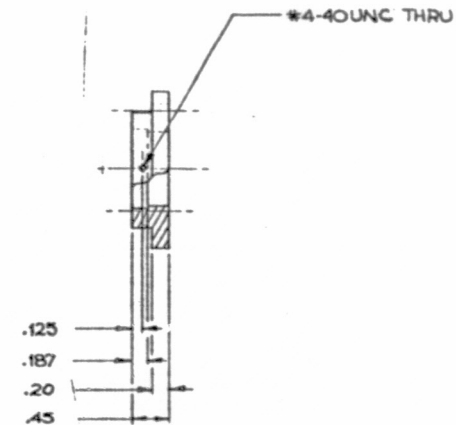
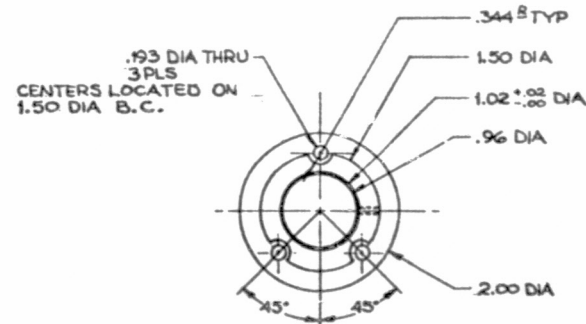
MATERIAL	
6061-T6 ALUM	
HEAT TREAT	

APPLIED FINISH	

DRAWN BY	F. J. MOSNA
CHECKED BY	
ENGR APPROVAL	

 MOTOROLA INC. Discrete Semiconductor Division			
TITLE:			
MIRROR MOUNT BACK PLATE			
SIZE	COCE IDENT. NO.	DRAWING NO.	
C	04713	R-0297-77-6	
SCALE FULL		WEIGHT	
		SHEET 1 OF 1	

 MOTOROLA INC. <i>Discrete Semiconductor Division</i>			
TITLE:			
MIRROR MOUNT- TOP PLATE			
SIZE	CODE IDENT NO	DRAWING NO	
C	04713	R-0297-77-5	
SCALE FULL		WEIGHT	SHEET 1 OF 1



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PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND
RETRIEVAL SYSTEM, WITHOUT PERMISSION IN WRITING FROM MOTOROLA.
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES.
DIMENSIONS ARE GIVEN IN DECIMALS OF AN INCH, UNLESS
OTHERWISE SPECIFIED. DIMENSIONS ARE TO BE MAINTAINED TO THE
TOLERANCES SPECIFIED IN THE FOLLOWING TABLE.

APPLICATION	USED ON
NEXT ASSEMBLY	

UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02, .XXX ± .005
MILLIMETERS .X ± .1, .XX ± .05
ANGULAR ± 1°
125 RMS ALL MACHINED
SURFACES
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5
BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE OR ISOGRAPHIC
PROJECTION IS USED.

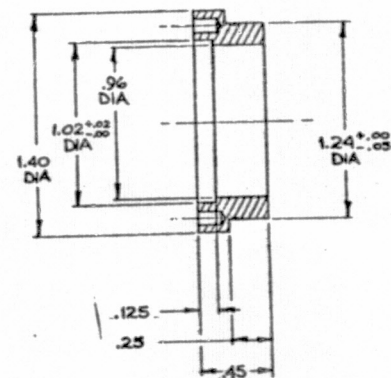
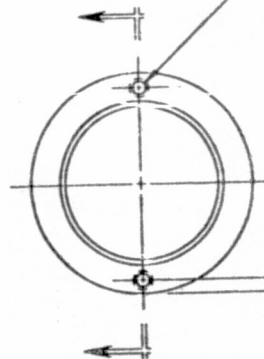
MATERIAL 6061-T6 AL	
HEAT TREAT 	
APPLIED FINISH 	
DRAWN F.J. MOSVA	DATE
CHECKED BY	DATE
APPROVED	DATE

MOTOROLA INC. Discrete Semiconductor Division	
TITLE: LENS HOLDER - FLUSH	
SIZE C	CODE IDENT. NO. 04713
SCALE FULL	WEIGHT
DRAWING NO. R-0272-71-45	SHEET 1 OF 1

10/27/81

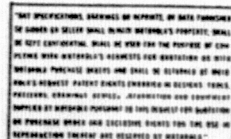
INCH 1/16

-.09 TYP



THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED.

APPROVAL _____



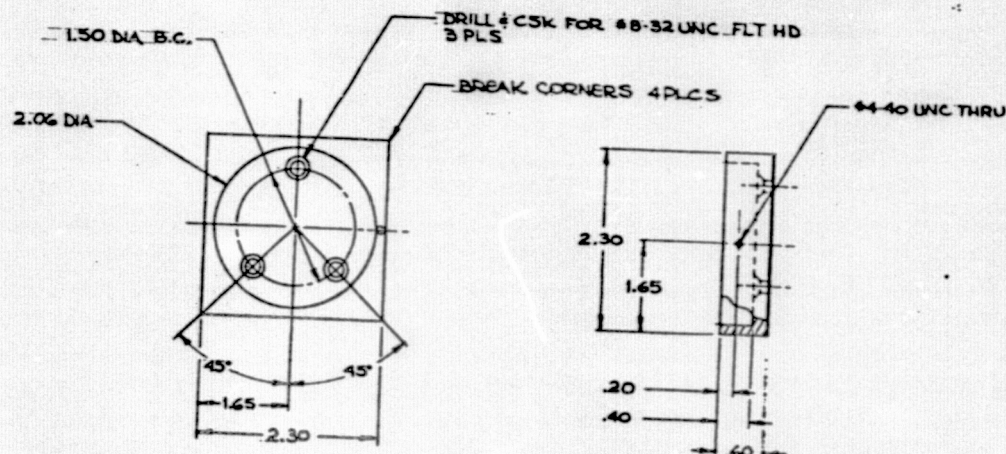
NEXT ASSEMBLY	USED ON
APPLICATION	

MATERIAL	
6061 T6 AL	
HEAT TREAT	
	
APPLIED FINISH	
	
DRAWN BY	DATE
F. J. MOSKA	
CHKD BY	DATE
FNDR APPROVAL	DATE

(AA) MOTOROLA INC.			
Discrete Semiconductor Division			
TITLE:			
MIRROR HOLDER			
DATE	QUANTITY	DRAWING NO.	
C	04713	R-0272-77-43	
SCALE FULL		WEIGHT	
		SHEET 5 OF 5	

NO	CARR BY	F.J. MOGNA	DATE	5-1-77	SIZE	CODE IDENT NO	BRANDING NO.
CALE	CHECKED BY		DATE		D	04713	R-0272-77-40
HS	FOR APPROVAL		DATE		SCALE FULL	WEIGHT	SHEET 1 OF 1

REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY ENGR.



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APPLICATION	USED ON

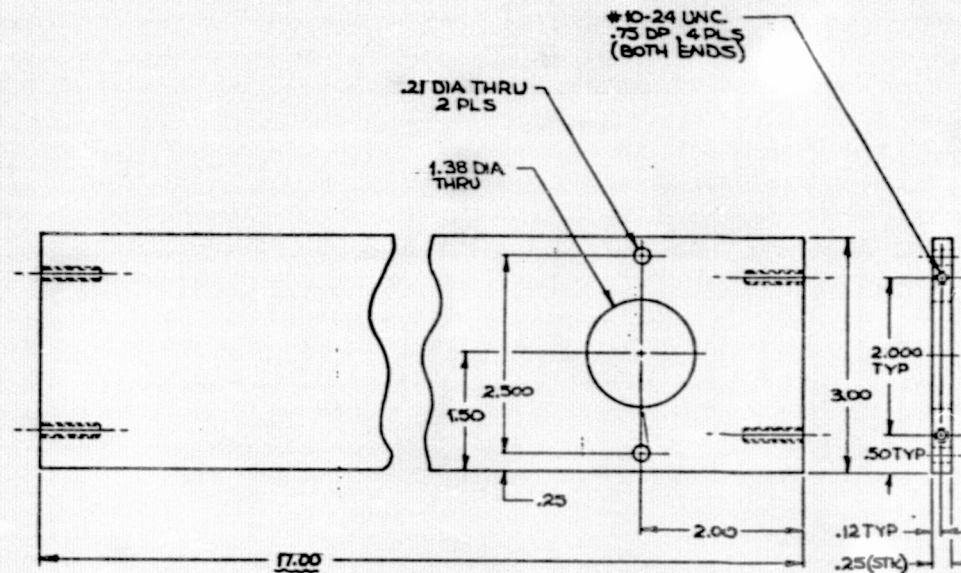
UNLESS OTHERWISE SPECIFIED:
TOLERANCES:
INCHES .XX ± .02 .XXX ± .005
MILLIMETERS .XX ± .XX
ANGULAR ± 1°
125 RMS ALL MACHINED SURFACES
FEATURE CONTROL SYMBOLS PER ANSI Y14.5
BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

MATERIAL	6061 T6 AL
HEAT TREAT	
APPLIED FINISH	
DRAWN BY	F. J. MOSNA
CHECKED BY	
APPROVAL	

MOTOROLA INC. Discrete Semiconductor Division			
TITLE: MIRROR HOLDER			
SIZE	CODE IDENT. NO.	DRAWING NO.	
C	04713	R-0272-77-43	
SCALE	FULL	WEIGHT	SHEET 1 OF 1

1/16" = 1"

INCH 1/16"



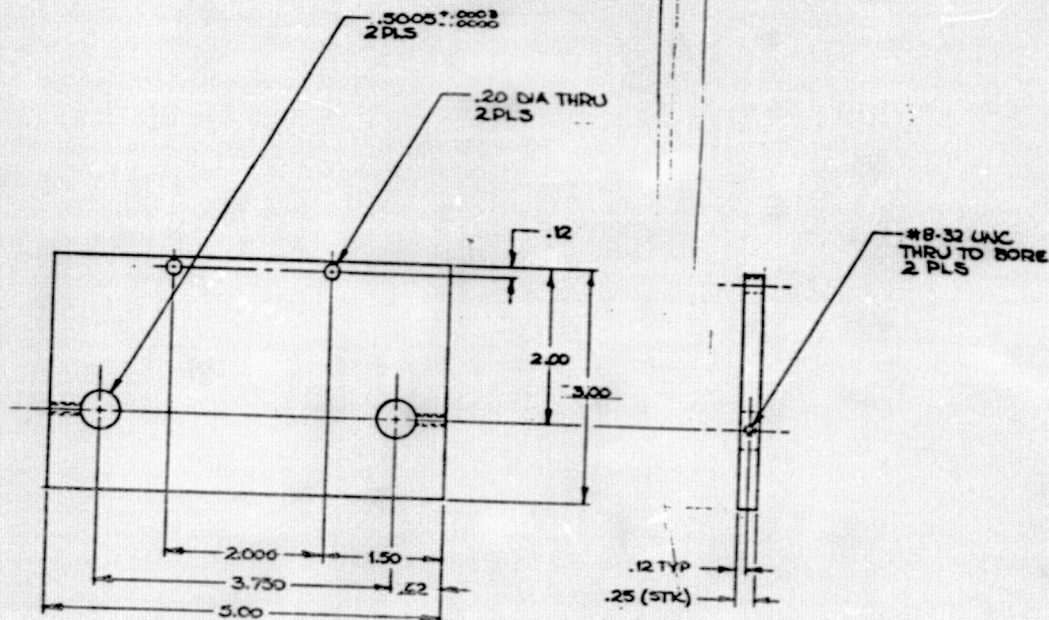
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UNLESS OTHERWISE SPECIFIED,
TOLERANCES:
INCHES .XX ± .02, .XXX ± .003
MILLIMETERS .X2 ± .XX ± .1
ANGULAR ±
125° RMS ALL MACHINED
SURFACES
FEATURE CONTROL SYMBOLS
PER ANSI Y14.5
BREAK ALL SHARP EDGES AND
CORNERS, REMOVE BURRS.
UNDERLINED DIM NOT TO SCALE
THIRD ANGLE ORTHOGRAPHIC
PROJECTION IS USED.

MATERIAL		6061-T6 ALUM	
HEAT TREAT		_____	
APPLIED FINISH		_____	
DRAWN BY	F. J. MOSNA	DATE	9-27-68
CHEKED BY		DATE	
ENG'N APPROVAL		DATE	

 MOTOROLA INC. Discrete Semiconductor Division			
TITLE:			
MIRROR MOUNT BACK PLATE			
SIZE	CODE IDENT. NO.	DRAWING NO.	
C	04713	R-0297-77-6	
SCALE FULL		WEIGHT	SHEET 1 OF 1

REVISIONS				
REV.	ECO NO.	CHANGE	DATE	BY ENGR



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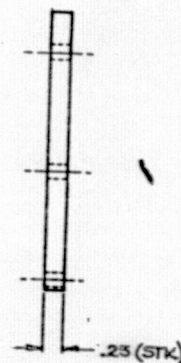
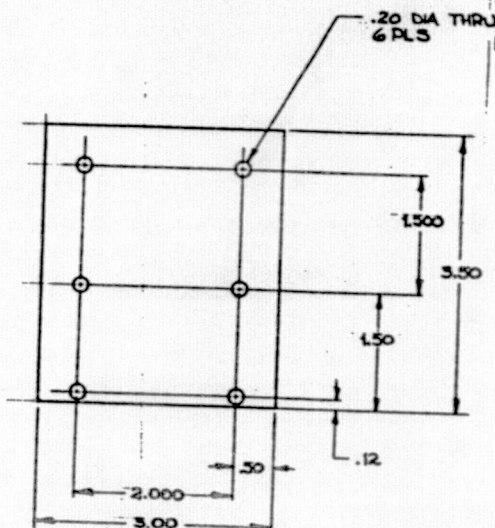
APPLICATION USED ON

UNLESS OTHERWISE SPECIFIED, TOLERANCES: DIMS .XX ± .02 .XXX ± .005 MILLIMETERS .XX ± .02 .XXX ± .005 ANGULAR ± 125 RMS ALL MACHINED SURFACES FEATURE CONTROL SYMBOLS PER ANSI Y14.5 BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS. UNDERLINED DIM NOT TO SCALE THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

MATERIAL 6061-T6 ALUM
HEAT TREAT
APPLIED FINISH
DRAWN BY F. J. MOSNA
CHECKED BY
DATE 9-22-77

(M) MOTOROLA INC.
Discrete Semiconductor Division
TITLE: MIRROR MOUNT - TOP PLATE
SIZE C CODE IDENT. NO. 04713 DRAWING NO. R-0297-77-5
SCALE FULL WEIGHT SHEET 1 OF 1

ORIGINAL PAGE IS
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REVISIONS				
REV	ECO NO	CHARGE	DATE	BY ENGR

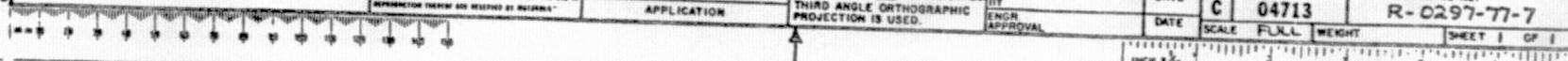
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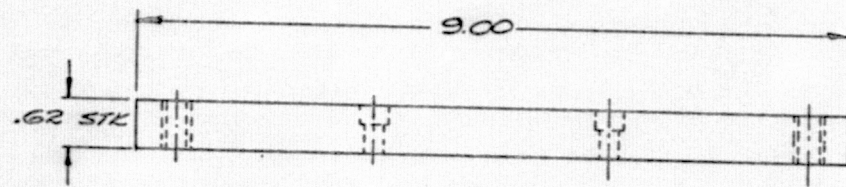
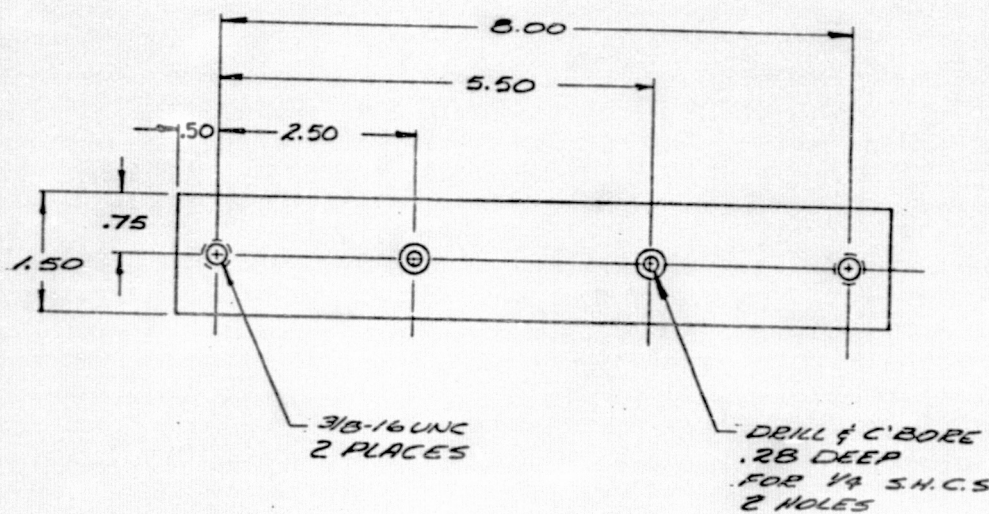
UNLESS OTHERWISE SPECIFIED, TOLERANCES: INCHES .XX ± .02 .XXX ± .005 MILLIMETERS .X ± .XX ± .ANGULAR ± 12.5° RNS ALL MACHINED SURFACES FEATURE CONTROL SYMBOLS PER ANSI Y14.5 BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS. UNDERLINED DIM NOT TO SCALE THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED.

MATERIAL 6061-T6 ALUM
HEAT TREAT
APPLIED FINISH
DRAWN BY F.J. MOSNA
CHECKED BY
ENGR APPROVAL

MOTOROLA INC.
Discrete Semiconductor Division
TITLE: MIRROR MOUNT - BOTTOM PLATE
SIZE C CODE IDENT. NO. 04713 DRAWING NO. R-0297-77-7
SCALE FULL WEIGHT SHEET 1 OF 1



REVISIONS				
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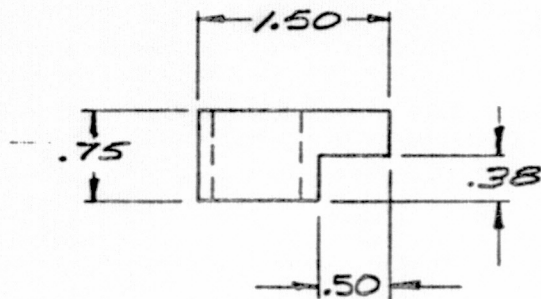
UNLESS OTHERWISE SPECIFIED, TOLERANCES:
 INCHES XX ± .001 XXX ± .005
 MILLIMETERS XX ± .1 XXX ± .5
 ANGULAR ± .1
 SURF. FINISH ALL MACHINED SURFACES
 FEATURE CONTROL SYMBOLS PER ANSI Y14.5
 BREAK ALL SHARP EDGES AND CORNERS, REMOVE BURRS.
 UNDERLINED DIM NOT TO SCALE
 THIRD ANGLE ORTHOGRAPHIC PROJECTION IS USED

NEXT ASSEMBLY USED ON APPLICATION

MATERIAL 6061-T6 ALUM		MOTOROLA INC. Discrete Semiconductor Division	
HEAT TREAT		TITLE: CAMPING BAR	
APPLIED FINISH		SIZE C	
DRAWN BY S. B. DAY		CODE IDENT. NO. 04713	
CHECKED		DRAWING NO. P-0272-77-47	
DATE		SCALE FULL	
DATE		WEIGHT	
DATE		SHEET OF	

Technical drawing of a mechanical part with dimensions and a note:

- Horizontal dimensions: $.12$, $.75$
- Vertical dimensions: $.27$, $.75$
- Left side dimension: $.21$
- Note: *FULL R* (with an arrow pointing to the rounded corner)



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OF POOR QUALITY

NEXT ASSEMBLY	USED ON
APPLICATION	

INCH x 10